313A
TRACKING
OSCILLATOR

OPERATING AND SERVICE MANUAL

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OPERATING AND SERVICE MANUAL

(HP PART NO. 00313-90001)

MODEL 313A
TRACKING OSCILLATOR

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01818-1

PRINTED: APRIL 1968

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Figure 1-1. Model 313A Tracking Oscillator

Table 1-1. Specifications

FREQUENCY RANGE:
As tracking oscillator: Same as 312A (10 kHz to 18 MHz) or H01-312A and H05-312A (10 kHz to 22 MHz).
As signal source: 10 kHz to 22 MHz in one band, continuous tuning.

FREQUENCY ACCURACY:
As tracking oscillator: 35 Hz ± 4 Hz above 312A tuning.
As signal source: ± 1% of maximum dial setting from 10 kHz to 2 MHz ± 3% of maximum dial setting from 2 to 8 MHz; ± 5% of maximum dial setting from 8 to 22 MHz.

FREQUENCY STABILITY:
As tracking oscillator: Same as 312A time base.
As signal source: Short term (5 min.) drift < 1 kHz in stable environment after warmup.

FREQUENCY RESPONSE: ± 0.1 dB 10 kHz to 22 MHz.

AMPLITUDE STABILITY: ± 0.1 dB for 90 days (0 to 55°C).

METER MODE:
312A Expand: Meter expands any 2 dB range of 312A meter indication from -7 to +3 dB using 312A recorder output. Meter range, -1 to +1 dB; tracking error +0.05 dB over full 2 dB range.

MAXIMUM OUTPUT: 0 or +10 dBm ± 0.1 dB, selectable at front panel.

OUTPUT ATTENUATOR: Three-section attenuator provides 0 to 99.9 dB attenuation in 0.1 dB steps.

ATTENUATOR ACCURACY:
0.9 dB section (0.1 dB steps): ± 0.02 dB.
9 dB section (1 dB steps): ± 0.1 dB.
90 dB section (10 dB steps): ± 0.1 dB to 50 dB, ± 0.2 dB to 90 dB.

RECORDER OUTPUT: 0.3 V for full scale. Output impedance 1 K ohm.

OUTPUT IMPEDANCE: 75Ω unbalanced (50Ω optional).

OUTPUT CONNECTOR: BNC female.

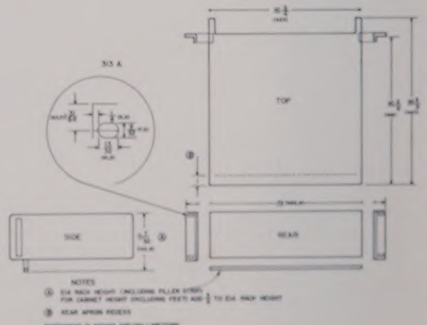
HARMONIC DISTORTION: More than 34 dB below fundamental.

NON-HARMONIC DISTORTION:
As tracking oscillator: More than 40 dB below fundamental.

As signal source: More than 50 dB below fundamental.

POWER: 115 or 230 V ± 10%, 50 to 1000 Hz, 30 W maximum.

DIMENSIONS:



SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Hewlett-Packard Model 313A Tracking Oscillator complements the Hewlett-Packard Model 312A Wave Analyzer in making system gain measurements, distortion checks, etc. The 313A has two modes of operation, a TRACK 312A mode and an INTERNAL mode. When used in the TRACK 312A mode, the 312A utilizes the 30 MHz Crystal Oscillator output and the Local Oscillator output of the 312A to provide output levels from -99.9 dB to +10 dBm in 0.1 dB steps and a frequency range between 10 kHz and 18 MHz. (10 kHz-22 MHz with H01-312A). When used in the INTERNAL mode, the 313A utilizes an internal Local Oscillator and 30 MHz Crystal Oscillator to generate output levels from -99.9 dB to +10 dBm in 0.1 dB steps and a frequency range between 10 kHz and 22 MHz. Table 1-1 lists the specifications for the 313A.

1-3. A special feature of the 313A is the Meter Expand function. When used in the Meter Expand function, the RECORDER OUTPUT of the 312A can be displayed on the 313A meter as 2 dB full scale. Any 2 dB between -7 dB and +3 dB on the 312A meter can be selected with 0.02 dB resolution on the 313A meter. The 313A also provides a RECORDER OUTPUT so that external instruments can be used to monitor the output.

1-4. ACCESSORY EQUIPMENT SUPPLIED.

1-5. The accessory equipment supplied with the 313A is listed in Table 1-2.

Table 1-2. Accessory Equipment Supplied

-hp- Part No.	Quantity	Description
11086A	3	Accessory Cables, 24"
8120-0078	1	Power Cord
5060-4940	1	15 Pin Extender Board
5060-0775	1	Rack Mounting Kit

1-6. INSTRUMENT AND MANUAL IDENTIFICATION.

1-7. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual or backdating information in the back of this manual will define differences between your instrument and the Model 313A described in this manual. If the serial number is preceded by a letter, the instrument was manufactured outside the United States.

SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also, check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-8. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-3. POWER REQUIRMENTS.

2-4. The Model 313A will operate from either 115 or 230 Vac, 50 - 1000 Hz. The instrument can be easily converted from 115 or 230 volt operation by changing the position of the slide switch located on the rear panel, so that the designation appearing on the switch matches the nominal voltage of the power source. A 0.3 ampere, slow-blow fuse is used for 115 volt and 0.15 ampere, slow-blow for 230 volt.

2-5. THREE-CONDUCTOR POWER CABLE.

2-6. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-7. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-8. INSTALLATION.

2-9. The -hp- Model 313A is fully transistorized; therefore no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F).

2-10. RACK/BENCH INSTALLATION.

2-11. The Model 313A is initially shipped as a bench-type instrument (unless ordered specifically as a rack type) with plastic feet and a tilt stand in place. Conversion to a rack-mounted instrument can be accomplished by using the rack mounting kit and instructions furnished with your instrument.

2-12. REPACKAGING FOR SHIPMENT.

2-13. The following is a general guide for repackaging for shipment. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

a. Place instrument in original container if available. If original container is not available, a suitable one can be purchased from your nearest -hp- Sales and Service Office.

If original container is not used,

b. Wrap instrument in heavy paper or plastic before placing in an inner container.

c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

e. Mark shipping container with "Delicate Instrument," "Fragile" etc.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Model 313A Tracking Oscillator has an INTERNAL mode of operation and a TRACK 312A mode of operation. In the INTERNAL mode of operation, the 313A Local Oscillator and Crystal Oscillator are used to generate output frequencies between 10 kHz and 22 MHz at levels between -99.9 dB and +10 dBm. In the TRACK 312A mode, the 313A Local Oscillator and Crystal Oscillator are disabled and these signals are replaced by inputs from the Model 312A. When the 312A signals are used, the 313A output level is still variable between -99.9 dB and +10 dBm but the frequency range is only from 10 kHz to 18 MHz. (10 kHz-22 MHz when used with H01-312A or H05-312A.

3-3. When the METER MODE switch is in the OUTPUT MONITOR position, the 313A front panel meter is used to indicate that the output of the 313A is calibrated, or it can be used in the 312A EXPAND position to display the 312A RECORDER OUTPUT on an expanded scale for increased resolution.

3-4. CONTROLS AND INDICATORS.

3-5. Figure 3-1 and Table 3-1 identifies and describes the function of all front and rear panel controls, connectors and indicators on the 313A.

3-6. METER MECHANICAL ZERO.

3-7. The meter should be mechanically zeroed before the 313A is used. To do this, insert some pointed object such as a toothpick or ball point pen into the recess on the adjustment wheel and adjust the meter until the needle rests directly over the -1.0 division marker.

3-8. TURN ON PROCEDURE.

a. Before connecting the 313A to a power source, insure that the 115/230 Vac slide switch on the rear panel is in the appropriate position.

b. Connect the 313A to the ac power source using the power cable supplied with the instrument.

CAUTION

WHEN THE MODEL 313A IS CONNECTED TO A POWER SOURCE, POWER IS AVAILABLE AT THE AUXILIARY POWER JACK ON THE REAR PANEL EVEN WHEN THE MODEL 313A IS TURNED OFF.

c. Depress the LINE ON/OFF switch and note that the ON/OFF indicator lamp illuminates.

3-9. OPERATION.

3-10. To operate the 313A in the INTERNAL mode, proceed as follows:

a. Place the OSCILLATOR MODE switch in the INTERNAL position. This energizes the internal Local Oscillator and Crystal Oscillator.

b. Connect a 75 ohm load to the output jack.

c. Place the METER MODE switch in the OUTPUT MONITOR position and note that the meter reads full scale on the CAL mark.

NOTE

A warmup time of 5 minutes should be allowed for the 313A circuits to stabilize. When the instrument is first turned on, the meter will read slightly above the CAL mark but will return to CAL after the required warmup time. If the meter does not read on the CAL mark ±2 divisions after warmup, refer to Paragraph 5-17 for Adjustment and Calibration procedure.

d. When the 313A is terminated in a 75 ohm load and the meter is reading directly on the CAL mark, the output level can be read directly from the attenuator dials if the MAX OUTPUT switch is in the 0 DBM position. When the MAX OUTPUT switch is in the +10 DBM position, +10 DBM must be added algebraically to the attenuator dial reading for a correct indication of output level.

e. Tune the 313A to the desired frequency using the continuously variable frequency control (MHz).

3-11. To operate the 313A in the TRACK 312A mode, proceed as follows:

a. Connect the LOCAL OSCILLATOR OUTPUT and 30 MHz OUTPUT on the rear panel of the 312A to the LOCAL OSCILLATOR INPUT and 30 MHz INPUT on the rear panel of the 313A.

b. Connect the output of the 313A through a 75Ω cable and a 75Ω feedthru termination (at the 312A end of the cable) to the 312A input.

c. Place the 313A OSCILLATOR MODE switch to TRACK 312A and set the attenuator to 00.0 dB. Set the MAX OUTPUT switch to 0 dBm and the METER MODE switch to OUTPUT MONITOR.

d. Set the 312A REFERENCE LEVEL to 0 dBm and the AMPLITUDE RANGE to 0 dB. Set the BAL UNBAL switch to UNBAL and the INPUT MODE to BRIDGED, 75. Set the RECEIVER MODE switch to AM.

e. The 312A meter should now indicate directly over the CAL mark and the 312A meter should indicate 0 dBm.

f. To expand the 312A meter indication, connect the 312A RECORDER OUTPUT to the 313A RECORDER INPUT and change the 313A METER MODE switch to 312A EXPAND. Adjust the SCALE OFFSET for a zero center scale reference. The 313A can expand any 312A meter indication between -7 dBm and +3 dBm.

3-12. NEGATIVE RECORDER INPUT.

3-13. If the 313A Meter Expand Amplifier is to be used with an instrument having a negative recorder output voltage, a minor modification must be made. To perform this modification, disconnect the wires connected to J10 pin 14 and J10 pin 9. Connect the wire removed from pin 14 to pin 9 and connect the wire removed from pin 9 to pin 14.

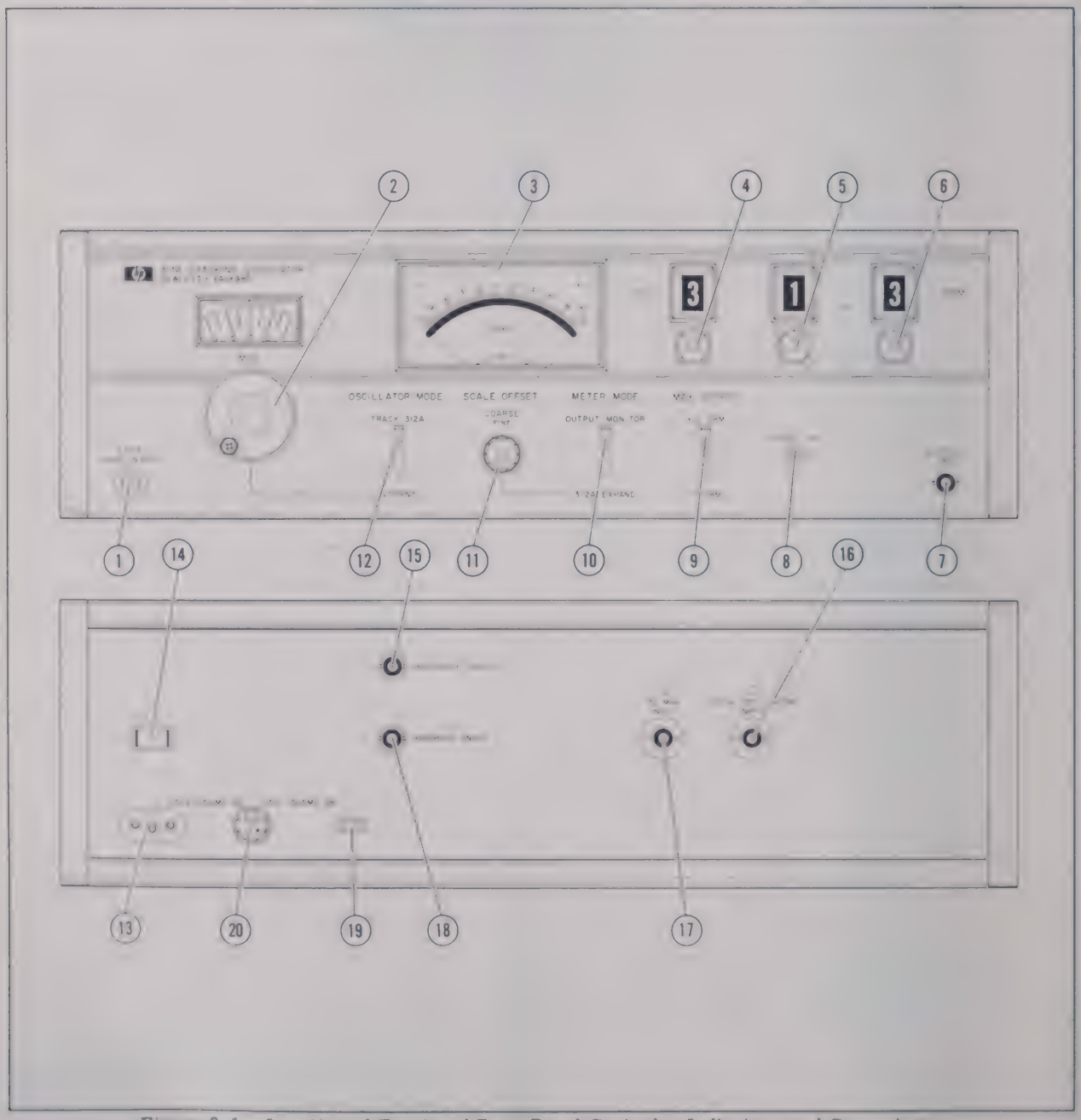


Figure 3-1. Location of Front and Rear Panel Controls, Indicators and Connectors

Table 3-1. Front and Rear Panel Controls, Indicators and Connectors

(1) Line ON/OFF Switch: When the instrument is connected to a power source and the switch is depressed, power is applied to the instrument and the lamp will illuminate indicating an ON condition.

(2) Frequency Selector: Selects output frequencies between 10 kHz and 22 MHz when operated in the INTERNAL mode.

(3) Meter: Reads on the CAL mark in the OUTPUT MONITOR position of the METER MODE Switch, indicating that the 313A output level is calibrated or displays the 312A RECORDER OUTPUT on an expanded scale in the 312A EXPAND position of the METER MODE switch.

(4) 10 DB Step Attenuator: Selects output attenuation from 0 to 90 dB in 10 dB steps.

(5) 1 DB Step Attenuator: Selects output attenuation from 0 to 9 dB in 1 dB steps.

(6) .1 DB Step Attenuator: Selects output attenuation from 0 to 0.9 dB in 0.1 dB steps.

(7) Output Connector: Provides a 75 ohm unbalanced output (50 ohm unbalanced, Option 01).

(8) OUTPUT CAL: Used to adjust the meter to indicate CAL.

(9) MAX OUTPUT Switch: In the 0 DBM position, the output level can be read directly from the attenuator dials. In the +10 DBM position, the output level is increased by +10 DBM. This +10 DBM increase in output level must be algebraically added to the attenuator dial reading for a correct indication of output level.

(10) METER MODE Switch: In the 312A EXPAND position, the RECORDER OUTPUT of the 312A is displayed on the 313A meter. In the OUTPUT MONITOR position, the 313A meter reads CAL indicating that the output of the 313A is calibrated. The output of the 313A can then be read directly in DBM from the attenuator dials provided the MAX OUTPUT switch is in the 0 DBM position.

(11) SCALE OFFSET: Adjusts the meter for center scale reference when making an expanded meter reading. Both a Coarse and Fine adjustment are provided.

(12) OSCILLATOR MODE Switch: In the TRACK 312A mode, the 313A Local Oscillator and Crystal Oscillator are disabled and the 312A outputs are selected to be used in the 313A. In the INTERNAL mode, the Model 313A Local Oscillator and Crystal Oscillator are activated.

(13) Input Power Receptacle: Connects 115/230 volts to the instrument.

(14) Output Power Receptacle. Provides 115/230 volts to auxiliary equipment when the 313A is connected to an ac source. This receptacle is active even when the 313A is turned off.

(15) RECORDER OUTPUT Connector: Provides a dc output proportional to the ac output signal. This output is provided so that it can be monitored by external equipments. Source resistance of this output is 1000 ohms.

(16) LOCAL OSCILLATOR INPUT Connector: Accepts the 312A LOCAL OSCILLATOR output when the 313A is operated in the TRACK 312A mode.

(17) 30 MHz INPUT Connector: Accepts the CRYSTAL OSCILLATOR output of the Model 312A when the Model 313A is operated in the TRACK 312A mode.

(18) RECORDER INPUT: Accepts the RECORDER OUTPUT of the 312A for expansion on the 313A meter.

(19) 115/230 Volt Switch: Selects either 115V or 230V primary ac input power.

(20) Fuse (F1): A 0.3 A slow-blow fuse F1 protects the instrument from overload when used on 115 volt primary power. When used on 230 volts ac, fuse F1 is a 0.15A slow-blow fuse.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL DESCRIPTION.

4-2. The Hewlett-Packard Model 313A TRACKING OSCILLATOR provides output levels from -99.9 dB to +10 dBm and an output frequency between 10 kHz and 22 MHz. Three front panel step attenuators provide 0 to 99.9 dB in 0.1 dB steps and a +10 dB increase in output level is available by means of the MAX OUTPUT switch. The 313A has an INTERNAL mode and a TRACK 312A mode of operation.

4-3. In the INTERNAL mode, the 313A Local Oscillator is activated and has a frequency range from 30 MHz to 52 MHz. The output of the Local Oscillator (A12) is mixed with a 30 MHz signal from the Crystal Oscillator A4. The output of Mixer A6 is the difference frequency, with a range between 0 and 22 MHz. This output is applied to the Low Pass Filter A7 where all frequencies above 22 MHz are attenuated. The Low Pass Filter output is coupled to Power Amplifier A8 where the signal is amplified and applied to the Output Attenuators and a Metering Circuit which monitors the output level. Additional attenuation is provided in 0.1 dB steps up to 0.9 dB by another step attenuator which controls the AGC voltage. The AGC voltage is applied to AGC Amplifier A5 which controls the 313A output level.

4-4. In the TRACK 312A mode of operation, the sequence is the same except that the 313A Local Oscillator and the 30 MHz Crystal Oscillator are disabled and external inputs from the 312A are substituted for these signals. The bandpass characteristics of the 312A are such that it is necessary to produce a frequency offset in the 313A output in order to keep the signal out of the 312A notch (See Figure 7-2). This 35 Hz offset is produced in the Single Sideband Generator A9 by mixing the 312A Crystal Oscillator output with a 35 Hz signal produced in the 313A.

4-5. The 313A has a Meter Expand Function which accepts an external input from the 312A RECORDER OUTPUT and expands the 312A meter reading for a 2 dB full scale (±1 dB center scale) deflection for increased resolution.

4-6. CIRCUIT DESCRIPTION.

4-7. Refer to Figures 7-4 through 7-9 for the following discussions.

4-8. POWER SUPPLY (A1).

4-9. The power supply circuits in the 313A contain two regulated supplies which produce +20 volts and -20 volt outputs. Both supplies are identical except that the negative supply uses a reference diode and the positive supply utilizes the negative supply for its reference.

4-10. The +20 volt supply uses a conventional series type regulator. Transistor A1Q2 is the sensing element whose base is tied to a voltage divider between +20 volts and -20 volts. Any change in the +20 volt output is sensed by A1Q2, amplified and applied to the emitter of A1Q1. Since transistor A1Q1 controls the base current of Q1, this change will cause the conduction of Q1 to change in such a direction as to keep the +20 volt output constant. Feedback capacitor A1C1 further aids regulation by coupling any changes in the +20 volt output back to the junction of A1R2 and A1R3 to produce higher loop gain. Since the +20 volt supply is referenced to the -20 volt supply, any change in the -20 volt supply will also change the +20 volt output. If for example, the -20 volt output should change to -21 volts, the positive supply would change to +21 volts. Adjusting A1R15 varies both supplies.

4-11. The -20 volt supply is identical in operation to the +20 volt supply except that A1CR6 is used to hold the emitter of A1Q4 at a constant voltage.

4-12. LOCAL OSCILLATOR (A12).

4-13. The Local Oscillator function is to produce stable frequencies between 30 MHz and 52 MHz. The oscillator frequency is controlled by a front panel knob which varies tuning capacitor C5.

4-14. The Oscillator is a field effect transistor (FET) A12Q1 whose drain load is a tuned circuit consisting of L1, C5, A12C1 and A12C2. The signal is taken from the drain of A12Q1 and coupled to the gate of A12Q2 which serves as a buffer amplifier and to match the oscillator output to the input of the Broadband Amplifier A11. Feedback is provided through A12C6, A12R4, and A12C5. Diodes A12CR1 and A12 CR2 serve to limit the amplitude of the feedback signal to 0.6 V p-p.

4-15. In the TRACK 312A mode, the oscillator is disabled by removing the B-voltage.

4-16. CRYSTAL OSCILLATOR (A4).

4-17. Crystal Oscillator A4 provides a 30 MHz signal through the AGC amplifier to the Mixer A6. The frequency of oscillations is controlled by A4Y1 which is a third overtone quartz crystal. Feedback is provided from the collector of A4Q1 through the crystal to the base of A4Q1. Collector circuit A4L2 and A4C4 form a 30 MHz tuned circuit. The output signal is coupled through A4R4 to the AGC Amplifier A5.

4-18. When the 313A is operated in the TRACK 312A mode, Crystal Oscillator A4 is disabled by removing B-voltage.

4-19. BROADBAND AMPLIFIER (A11).

4-20. Broadband Amplifier A11 consists of three stages of amplification and receives its input from one of two sources depending upon the position of the front panel OSCILLATOR MODE switch.

4-21. When the OSCILLATOR MODE switch is in the INTERNAL position, A11K1 is deenergized and the Model 313A Local Oscillator is coupled to the base of A11Q1. During the time that A11K1 is deenergized, A11K2 is energized and the External Oscillator Input is grounded.

4-22. When the 313A is operated in the TRACK 312A mode, A11K2 is deenergized and A11K1 is energized. During this time the ground is removed from the external LOCAL OSCILLATOR INPUT and the external signal is fed through A11K1 to the base of A11Q1. The 313A Local Oscillator is disabled during this time.

4-23. Amplifier A11Q1 has a 50Ω input impedance. Here the signal is amplified and coupled by A11C6 to the base of A11Q2 which has as its load, inductor A11L1 which helps shape the overall frequency response to the Broadband Amplifier. The signal is then coupled by A11C8 to emitter follower A11Q3 which has a low output impedance to match the input of Mixer A6.

4-24. DELTA OSCILLATOR (A2).

4-25. Delta Oscillator A2 is a phase shift oscillator which produces a 35 Hz signal to be used by the Single Sideband Generator. The frequency of oscillation is determined by A2C1 - A2R3 and A2C3 - A2R8. The reactances of A2C1 and A2C3 will be equal to the resistance of A2R3 and A2R8 respectively at the frequency of oscillation. Feedback is provided between the output of A2Q5 and the input of A2Q1.

4-26. Lamp A2DS1 is included to provide amplitude stability. If the amplitude of the signal across A2R12 should increase, the resistance of A2DS1 increases and reduces the gain of A2Q5 to keep the output amplitude constant. Two outputs are provided to the Single Sideband Generator, one at 0° and one at 90°.

4-27. BUFFER AMPLIFIER (A10).

4-28. Buffer Amplifier A10 provides isolation between the external 30 MHz INPUT and the Single Sideband Generator A9. When the 313A is operated in the TRACK 312A mode, the Buffer Amplifier is energized by applying B- voltage through the OSCILLATOR MODE switch located on the front panel.

4-29. Amplifier A10Q1 has a 50Ω input impedance and receives its input from a BNC connector J3 located on the rear panel of the 313A. The collector circuit of A10Q1 is tuned to 30 MHz and couples the signal to A10Q2 which is also tuned to 30 MHz. The output of A10Q2 goes to the Single Sideband Generator to be used as a switching signal.

4-30. SINGLE SIDEBAND GENERATOR (A9).

4-31. The function of the Single Sideband Generator is to mix the 30 MHz Crystal Oscillator frequency output of the Model 312A with a 35 Hz signal in the 313A. This mixing in the Single Sideband Generator produces a resultant frequency at 29.999965 MHz which is mixed with the Local Oscillator output of the Model 312A in Mixer A6. This 35 Hz offset is necessary because of the bandpass characteristics of the Model 312A. When making a closed loop test of an instrument, the output of the 313A is coupled to the device under test. The output of the device under test is then fed to the input of the 312A where it is mixed with a Local Oscillator frequency 30 MHz above the input signal frequency. This 30 MHz difference frequency falls into a notch in the 312A bandpass. Therefore, it is necessary to produce a slight offset in the 313A output so that this signal can be passed by the 312A.

4-32. Operation of the Single Sideband Generator can be best understood by referring to Figure 4-1. The 30 MHz Crystal Oscillator Input signal current from Buffer Amplifier A10 is phase advanced 45 degrees by capacitor A9C1 and is retarded 45 degrees by inductor A9L1. The signals at the primaries of A9T1 and A9 T2 are thus phase shifted 90 degrees with respect to each other. The two inputs from the 35 Hz Delta Oscillator are also 90 degrees apart in order to satisfy the trigonometric identities shown in Figure 4-1. Assume that the top of A9T1 secondary is in its positive half cycle and the bottom of A9T1 is in its negative half cycle. Diodes A9CR1 and A9CR2 are reverse biased and no signal current flows. Terminal 2 of A9T3 is therefore an open circuit. When the 30 MHz switching signal reverses in phase, diodes A9CR1 and A9CR2 are now forward biased and signal current flows through transformer A9T1, A9CR2, A9R7 and A9CR1. Terminal 2 of A9T3 is now effectively grounded and the signal is induced into the secondary of A9T3. The operation of the remaining half of the Single Sideband Generator is identical to the first except that the switching signal at A9T2 is 90 degrees phase shifted with respect to the signal at A9T1.

4-33. The Single Sideband Generator A9 accomplishes multiplication of the 35 Hz Delta Oscillator frequency (f_{Δ}) by the 30 MHz switching signal (f_{sw}) as defined by the trigonometric functions.

Mixer #1: $(\sin f_{sw}t) \times (\sin f_{\Delta}t) = 1/2 \left[\cos (f_{sw} + f_{\Delta}) t - \cos (f_{sw} - f_{\Delta}) t\right]$

Mixer #2: $(\cos f_{sw}t) \times (\cos f_{\Delta}t) = 1/2 \left[\cos (f_{sw} + f_{\Delta}) f + \cos (f_{sw} - f_{\Delta}) t\right]$

4-34. The outputs of Mixer #1 and Mixer #2 are added algebraically in A9R10 for an output of $\cos (f_{sw} + f_{\Delta}) t$. The mixers are balanced so that the switching frequency (f_{sw}) does not appear in the output. Resistors A9R1 and A9R2 keep any reflections back into the primaries of A9T1 and A9T2 constant and make them appear purely resistive. Capacitors A9C2 and A9C3 are used to trim out any reactances that might be reflected back into the primaries of A9T1 and A9 T2 respectively.

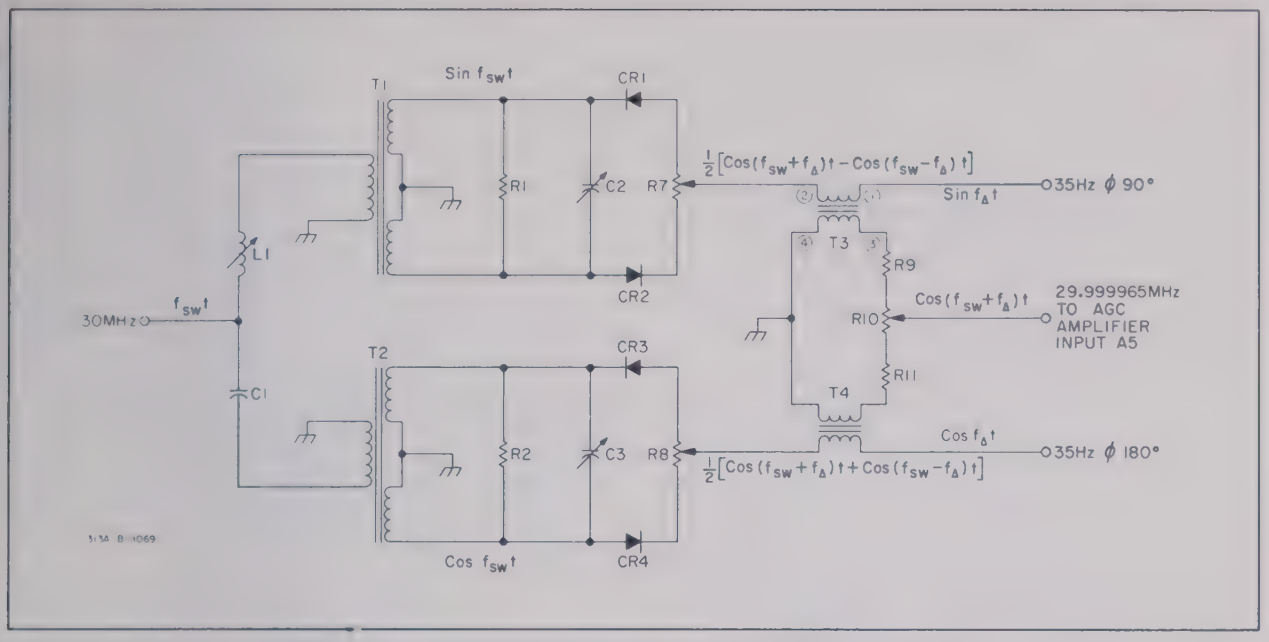


Figure 4-1. Single Sideband Generator A9 Simplified Schematic

4-35. AGC AMPLIFIER. (A5)

4-36. The AGC Amplifier receives its input from either the Crystal Oscillator A4 in the INTERNAL mode or from the Single Sideband Generator A9 in the TRACK 312A mode.

4-37. In the INTERNAL mode, the 30 MHz crystal controlled signal from A4 is coupled to the base of A5 Q1 where it is amplified. The output of A5Q1 is then coupled to the AGC control circuit consisting of A5T1, A5C6, A5CR1, A5CR2 and A5T2. The AGC control circuit sets the signal amplitude depending upon the magnitude of the AGC control voltage. This control voltage is a bias for A5CR1 and A5CR2 which determines their conduction and thus the amount of attenuation of the signal through the diodes. Since the AGC circuit is a closed loop, any change in the 313A output amplitude will cause a corresponding change in the AGC control voltage by the AGC Control Amplifier A3. Thus the gain of AGC Amplifier A5 can be controlled by a dc voltage. This change in AGC voltage acts to keep the output level of the 313A constant.

4-38. In the TRACK 312A mode the input to the AGC Amplifier comes from the Single Sideband Generator A9 and the 30 MHz Crystal Oscillator A4 is disabled. This sideband signal is 29.999965 MHz which is the difference between the 35 Hz signal from the Delta Oscillator A2 and the 30 MHz Crystal Oscillator signal from the 312A.

4-39. MIXER (A6).

4-40. The Mixer A6 is a balanced modulator that receives one input from the Broadband Amplifier A11 and the other from the AGC Amplifier A5. The input from the Broadband Amplifier can vary from 30 MHz to 52 MHz depending upon the setting of the 313A front panel frequency control. The input from the AGC Amplifier is 30 MHz which comes from Crystal Oscillator A4 when operated in the INTERNAL mode or from an external source when operated in the TRACK 312A mode.

4-41. The Mixer output contains both the sum and difference frequencies and since it is desirable to use the difference frequency, the output is coupled to Low Pass Filter A7 where all frequencies above 22 MHz are greatly attenuated.

4-42. LOW PASS FILTER (A7).

4-43. Low Pass Filter A7 is 13 pole Tchebycheff filter whose function is to pass all frequencies between dc and 22 MHz uniformly while attenuating all undesirable frequency components above 22 MHz. Sharp cutoff occurs at approximately 24 MHz in order to eliminate any unwanted harmonics and noise components. The output is coupled to Power Amplifier A8 for further amplification.

4-44. POWER AMPLIFIER (P/O A8).

4-45. The Power Amplifier is located on the Module A8 along with the 10 dB Attenuator pad and the Average Detector. The Power Amplifier consists of seven stages of amplification, A8Q1 through A8Q7 along with associated biasing transistors, A8Q8 through A8Q12. Emitter follower A8Q1 provides isolation between the Low Pass Filter output and the amplifier. Emitter follower A8Q7 provides isolation and impedance matching with the 10 dB pad and the input to the average detector.

4-46. Since it is desirable that the amplifier gain be as flat as possible over the 0-22 MHz range, negative feedback is provided in two different ways. The first

method provides negative feedback through resistors tied between the collectors of A8Q2 through A8Q6. Coils A8L1 and A8L2 are provided for high frequency shaping. The second method of feedback maintains constant amplifier gain by controlling the conduction level of transistors A8Q2 through A8Q6. Biasing transistors A8Q8 through A8Q12 will sense any change in the conduction level of A8Q2 through A8Q6 respectively and changes the dc bias on these transistors, thus restoring the collector voltage. The bases of all biasing transistors are tied together to a fixed voltage so that only changes in the signal amplifier collector voltage will determine conduction.

4-47. Emitter follower A8Q7 has two outputs, one goes to the Average Detector and the second output goes to a 10 dB attenuator pad which is controlled by a front panel switch marked MAX OUTPUT. When the switch is in the +10 DBM position, A8K1 is energized, shorting A8R45 and A8K2 is deenergized which removes ground from A8K46, thus providing a +10 DBM increase in the Model 313A output. This +10 DBM increase in output level must be algebraically added to the attenuator dial reading for a correct indication of output level. In the 0 DBM position of the switch, 10 dB of attenuation is inserted by energizing A8K2 and deenergizing A8K1.

4-48. AVERAGE DETECTOR (P/O A8).

4-49. The Average Detector receives its input from the Power Amplifier through A8R49 which is selected for an optimum loop gain. The output of emitter follower A8Q13 is then fed to A8Q14 which has a high output impedance so that maximum signal current will flow in diodes A8CR1 and A8CR2. Both capacitors A8C35 and A8C36 establish a positive potential at the diode junctions. An increase in signal amplitude to the detector will cause the charge on A8C36 to increase and the charge on A8C35 to decrease. This change is then coupled to the AGC loop which cancels any variations that might occur. Resistor A3R31 is used to adjust the output level. The output of the Average Detector goes to the AGC Differential Amplifier and to the Metering Circuit.

4-50. ATTENUATORS (A13, A14 and A15).

4-51. Attenuator A13 provides 0 to 90 dB attenuation by switching different combinations of the 60 dB, 30 dB, 20 dB and 10 dB attenuator pads. Attenuator A14 provides 0 to 9 dB attenuation by switching combinations of the 6 dB, 3 dB, 2 dB and 1 dB attenuator pads. These two attenuators are connected in series for a total range of 0 to 99 dB. A 25Ω resistor is connected in series with the output of A14 to form a 75Ω output.

4-52. Attenuator A15 works in conjunction with the AGC circuit to control the output of the 313A. This attenuator provides a shunt current path around A3Q1. This change in current through A3Q1 changes its collector voltage and thus the AGC voltage. The change in AGC voltage is coupled to AGC Amplifier A5 where its gain is controlled in accordance with the resistance values selected in the 0.1 dB Step Attenuator. The output of the 313A can be changed in 0.1 dB steps up to 0.9 dB by Attenuator A15.

4-53. METER EXPAND AMPLIFIER (P/O A3).

4-54. The purpose of the Meter Expand Amplifier is to use the RECORDER OUTPUT of the Model 312A and expand the reading on a 2 dB full scale meter movement so that better resolution can be obtained. The input to the Meter Expand Amplifier comes from a BNC type connector J5 on the rear panel and is coupled directly to A3Q9. Transistors A3Q9 and A3Q10 form a differential amplifier with high impedance A3Q11 acting as their constant current source. Transistors A3Q7 and A3Q8 amplify the signal and reference it to ground before being applied to the meter. Transistor A3Q12 is in parallel with meter M1 and is used for calibration. Conduction of A3Q12 is controlled by A3R31. Transistor A3Q13 is a temperature compensating device for A3Q11 and A3Q12. If the Vbe of A3Q11 should change because of temperature variations, this change will be exactly compensated for by the change in A3 Q13 due to this temperature change. The emitter of A3Q13 is held at a constant potential by zener diode A3CR1.

4-55. When the 313A is used in the Meter Expand function with a given input to transistor A3Q9, the Model 313A meter is adjusted by the SCALE OFFSET for a zero center scale reference reading. Since the Meter Expand Amplifier has a constant gain with a given setting of the SCALE OFFSET, any variations in the input will cause deflection of meter M1. A 1 dB change in the input will cause a full scale deflection of M1. When operated in the Meter Expand function, the output that normally drives M1 is routed through the Meter Expand switch to a dummy load consisting of R4 and R5.

4-56. Meter M1 is a 300 μA taut band zero left movement which is calibrated for a 2 dB full scale deflection. When the 313A is operated in the OUTPUT MONITOR mode, the meter deflects to the CAL mark. The output is then calibrated and can be read directly from the attenuator dials provided the MAX OUTPUT switch is in the 0 DBM position.

4-57. AGC CONTROL AMPLIFIER (P/O A3).

4-58. The AGC Control Amplifier is part of module A3 and its function is to use the output of the Average Detector to establish an AGC voltage. This AGC voltage is used by the AGC Amplifier A5 in maintaining a uniform output level in the 313A.

4-59. The input to the AGC Control Amplifier is applied to the emitter of A3Q1 and A3Q2 with A3Q2 acting as a temperature compensating device for A3Q1. The AGC voltage developed in the AGC Amplifier is determined by the amount of current flowing through transistor A3Q1. The 0.1 dB Step Attenuator is connected across transistor A3Q1 and is used to shunt current around A3Q1. By shunting current around A3Q1, the AGC voltage changes and thus the output level of the 313A. The output of A3Q1 is coupled to a feedback amplifier consisting of transistor A3Q3 through A3Q6. Feedback path is from the junction of A3R10 and A3R12 to the base of differential amplifier transistor A3Q4. The AGC level can be set by adjusting A3R14.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary in the service and maintenance of the -hp- Model 313A. Included are performance checks, adjustment and calibration procedures and troubleshooting procedures.

5-3. The test equipment needed to properly maintain and service the 313A is listed in Table 5-1. Included in Table 5-1 is the equipment to be used, required specifications and recommended type. If the recommended model is not available, other equipments may be substituted provided they meet the required specifications.

5-4. METER MECHANICAL ZERO.

5-5. Mechanical zeroing of the front panel meter should be performed before any performance checks or adjustments are performed. To do this, turn the equipment off for 30 seconds to allow time for all capacitors to discharge and proceed with the procedure described in Paragraph 3-6.

5-6. FACTORY SELECTED VALUES.

5-7. Factory selected values are denoted on the schematic diagrams by an asterisk. Reference is also made to the paragraph number in the manual where the method of selection can be found.

5-8. PERFORMANCE CHECKS.

5-9. The performance checks presented in this section are in-cabinet checks designed to compare the 313A with its published specifications. These checks can be used for incoming inspection, periodic maintenance checks and to verify performance after adjustment or repair.

5-10. DIAL ACCURACY CHECK.

a. Connect the 313A output to the electronic counter using an RG-59B/U (75Ω) cable and a 75Ω feedthru termination and set the 313A controls as follows:

OSCILLATOR MODE . . . . INTERNAL
METER MODE . . . . . OUTPUT MONITOR
ATTENUATORS 00.0
MAX OUTPUT . . . . . +10 DBM

b. Adjust the electronic counter controls to read frequency.

c. Check the frequency dial accuracy at 1 MHz and at 2 MHz. The electronic counter reading should match the dial setting ± 220 kHz.

d. Check the frequency dial accuracy at all integral MHz markers from 2 MHz to 8 MHz. The electronic counter reading should match the dial setting ± 660 kHz.

e. Check the frequency dial accuracy at all integral MHz markers from 8 MHz to 22 MHz. The electronic counter reading should match the dial setting ± 1.1 MHz.

f. If steps a through e do not meet specifications, refer to Paragraph 5-17 for adjustment and calibration procedures.

5-11. OUTPUT MONITOR CHECK.

a. Set the Model 313A controls as follows:

OSCILLATOR MODE . . . . INTERNAL
METER MODE . . . . . OUTPUT MONITOR
MAX OUTPUT . . . . . +10 DBM
FREQUENCY DIAL . . . . 1 MHz
ATTENUATORS . . . . . 00.0 DB

b. Set the 400AC Voltmeter to the 1 V range and connect it to the output of the 313A using a 75 ohm cable and a 75 ohm feedthrough termination at the voltmeter end of the cable.

c. The 313A meter should read directly over the CAL mark on the meter face and the 400F should indicate 0.866 V ± 0.008 V (0.707 ± 0.007 Option 01).

d. If the Output Monitor Check does not meet the specifications of step c, refer to Paragraph 5-17 for Adjustment and Calibration Procedure.

5-12. METER EXPAND AND TRACKING CHECK.

a. Connect the 313A, Meter Expand Test Set and the 1 dB/step substitution attenuator as shown in Figure 5-1.

b. Change the 313A METER MODE switch to 312A EXPAND.

c. Connect the 3440A dc Digital Voltmeter to the test point on the Meter Expand Test Set and adjust the output of the test set to precisely 1.000 V.

d. Turn the substitution attenuator full clockwise (0dB). Adjust the 313A SCALE OFFSET Coarse control full counterclockwise with the Fine Control centered. The 313A meter should read 0.0 or less.

Table 5-1. Required Test Equipment and Accessories

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
Oscilloscope	Passband: DC to 30 MHz Sensitivity: 50 mV/cm Input Impedance: 1 MΩ	-hp- Model 175A with 1752B Vertical Plug-in and 1780A Horizontal Plug-in
Wave Analyzer	Local Oscillator Output: 50 mV into 50 ohms 30 MHz Output: 30 mV into 50 ohms Recorder Output: 1 V maximum into 1000 ohms	-hp- Model 312A HA 6
Wave Analyzer	Selectivity: ± 30 Hz at least 60 dB down Dynamic Range: 70 dB Input Reference Level: 1 volt	-hp- Model 302A USE
Electronic Counter	Frequency Range: 0 to 22 MHz Accuracy: ± 10 Hz	-hp- Model 5245L
Digital Voltmeter	Range: 1 V, 10 V and 100 V Accuracy: 0.1% Resolution: 4 digits Sensitivity: 1 mV full scale	-hp- Model 3440A
DC Multi-Function Plug-In	Accuracy: 0.1% Range: 1 V, 10 V and 100 V	-hp- Model 3444A
DC Null Voltmeter	Range: 10 mV Full Scale 30 μV Center Scale Accuracy: ± 2% Input Impedance: 100 kΩ	-hp- Model 419A
Bucking Supply 0-10 mV	See Figure 5-2 for schematic a. Resistor: fxd 6500Ω ± 1% R1 b. Resistor: var 500Ω ± 10% R2 c. Resistor: var 50Ω ± 5% R3 d. Battery: 1.34 V	 -hp- Part No. 0811-0392 -hp- Part No. 2100-0324 -hp- Part No. 2100-1481 Mallory RM-42R
Thermal Converter	Output: 3.5 mV dc output for 700 mV ac input Impedance: 75Ω Accuracy: 0.25% 10 kHz to 22 MHz	-hp- Model H01-11050A
Thermal Converter	Output: 5 mV dc output for 700 mV ac input (Option 01 only) Impedance: 50Ω Accuracy: 0.25% from 10 kHz to 22 MHz	-hp- Model 11050A
AC Voltmeter	Sensitivity: 100 μV Full Scale Accuracy: 0.5% at 866 mV at 1 MHz	-hp- Model 400F with known accuracy
AC Voltmeter	Sensitivity: 10 mV Full Scale Accuracy: 1% Passband: 500 kHz to 70 MHz	-hp- Model 3406A
Amplifier	Passband: 10 kHz to 22 MHz Gain: 40 dB	-hp- Model 461A
Distortion Filter	Notch Frequency: 1 MHz	See Figure 5-5
Distortion Filter	Notch Frequency: 9.5 MHz	See Figure 5-5
Distortion Filter	Notch Frequency: 20.5 MHz	See Figure 5-5
Meter Expand Test Set	See Figure 5-1 for schematic a. Resistor: fxd 464Ω ± 1% R1 b. Resistor: var 75Ω ± 10% R2 c. Resistor: fxd 56.2Ω ± 1% R3 d. Resistor: fxd 49.9Ω ± 1% R4 e. Resistor: fxd 1 kΩ ± 1% R5	 -hp- Part No. 0698-0090 -hp- Part No. 2100-0076 -hp- Part No. 0757-1001 -hp- Part No. 0757-0072 -hp- Part No. 0757-0021

Table 5-1. Required Test Equipment and Accessories (Cont'd)

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
10 dB/Step Substitution Attenuator	Range: 0 to 120 dB in 10 dB steps	-hp- Model 355D with known accuracy
1 dB/Step Substitution Attenuator	Range: 0 to 12 dB in 1 dB steps	-hp- Model 355C with known accuracy
50Ω Feedthru	Accuracy: 1% (Option 01 only)	-hp- Model 11048B
75Ω Feedthru Termination	Accuracy: 1%	-hp- Model 11094A
75Ω to 50Ω Feedthru Termination	Accuracy: 0.25% Input Impedance: 75Ω Output Impedance: 50Ω	See Figure 5-3
Probe	Attenuation: 10:1 Passband: DC to 30 MHz Accuracy: 2%	-hp- Model 10001A
Cable	Impedance: 50Ω Length: 24" (3 supplied with 313A	-hp- Model 11086A
Cable, BNC to Alligator Clip	Length: 44"	-hp- Model 11037A
Cable, BNC to BNC	Impedance: 50Ω Length: 48" (Option 01 only)	10503A

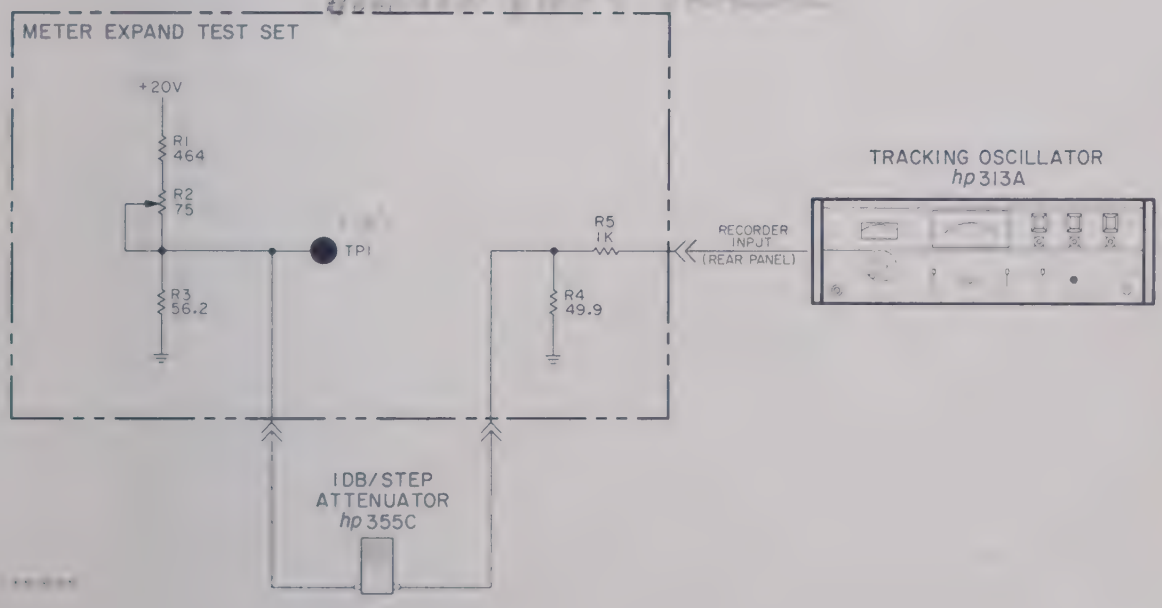


Figure 5-1. Meter Expand and Tracking Test Setup

e. Adjust the 313A SCALE OFFSET control so that the 313A meter reads +1.0. Turn the substitution attenuator 2 steps counterclockwise (2 dB). The 313A meter should read -1.0 ± 0.05 dB.

f. Using the procedure outlined in step e, continue checking the 313A meter tracking through the entire range of the SCALE OFFSET control. In each step, the 313A meter should read -1.0 ± 0.05 dB.

g. With the substitution attenuator set to 10 dB, turn the 313A SCALE OFFSET Coarse control full clockwise with the Fine control centered. The 313A meter should read 0.0 or greater.

h. If the Meter Expand and Tracking performance checks do not meet published specifications, refer to Paragraph 5-17 for Adjustment and Calibration procedures.

5-13. OUTPUT FREQUENCY RESPONSE CHECK.

NOTE

If a 312A Wave Analyzer is available, perform steps a through l. If a 312A is not available, perform steps i through l.

a. Connect the 313A, 312A, Thermal Converter, Bucking Supply and 419A DC Null Voltmeter as shown in Figure 5-2.

b. Set the 313A controls as follows:

OSCILLATOR MODE . . . TRACK 312A
METER MODE . . . . . OUTPUT MONITOR
MAX OUTPUT . . . . . +10 DBM
ATTENUATORS 00.0

c. Set the 312A FREQUENCY RANGE to 0 and adjust the variable frequency control for 1000.00 kHz.

d. With the Bucking Supply OFF, set the 419A to the 10 mV range and zero the meter. Push the VM button on the 419A.

e. Turn ON the Bucking Supply and adjust the controls for a null on the 419A meter.

f. Turn the 419A to the 300 μV range and if necessary readjust the controls on the Bucking Supply for a null on the 419A meter.

g. Turn the 313A 0.1 dB attenuator one step counterclockwise and note the reading on the 419A meter. This represents 0.1 dB deviation for the following checks. Return the 313A 0.1 dB attenuator to 0.

h. Using the FREQUENCY RANGE and variable frequency control, slowly tune the 312A through the frequency range between 10 kHz and 18 MHz observing any deviations on the 419A meter. The 419A meter should not deviate more than the value noted in step g.

i. Change the 313A OSCILLATOR MODE switch to INTERNAL and set the 313A frequency dial to 1 MHz. If necessary readjust the Bucking Supply for a null on the 419A meter.

j. Turn the 313A 0.1 dB attenuator one step counterclockwise and note the reading on the 419A meter. This reading represents 0.1 dB deviation. Return the attenuator to 0.

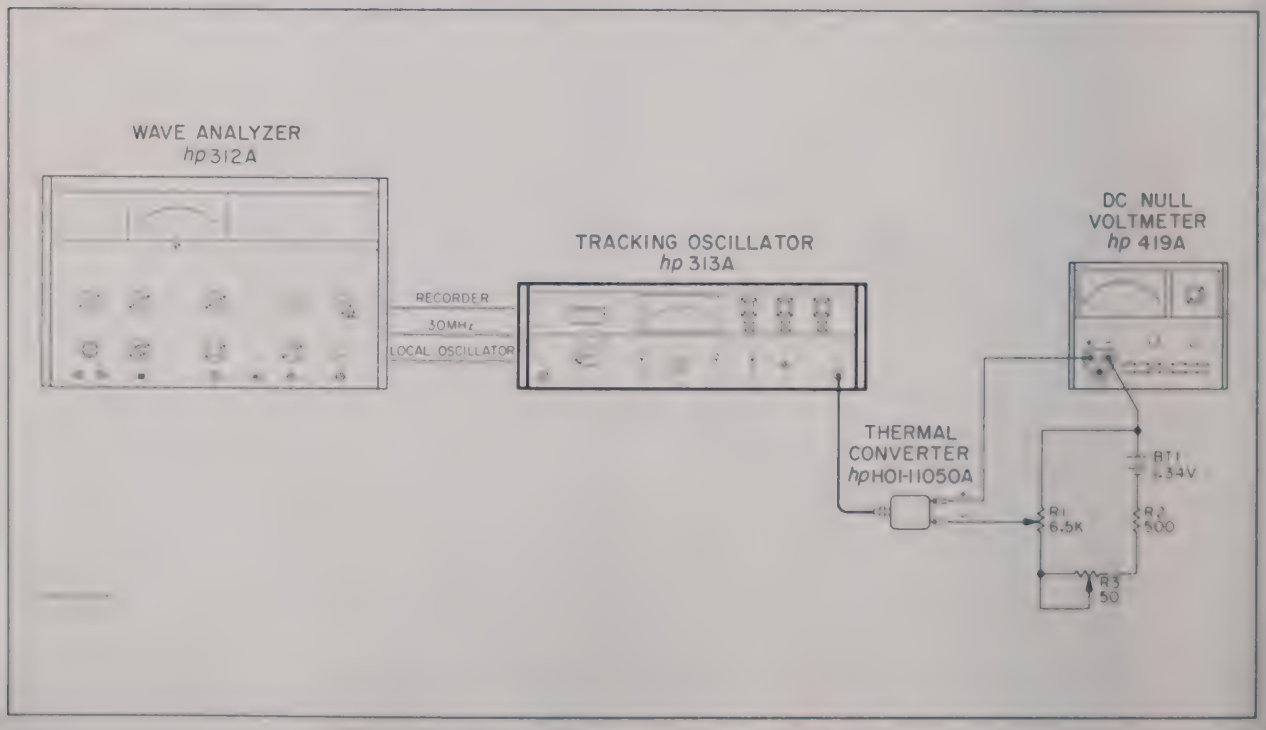


Figure 5-2. Output Frequency Response Test Setup

k. Slowly tune the 313A through the frequency range of 10 kHz to 22 MHz noting any deviations on the 419A meter. Any deviations noted should not exceed the value recorded in step j.

l. Change the 313A MAX OUTPUT switch to 0 DBM and the 419A RANGE switch to 30 μV. Repeat steps i through k.

m. If the Output Frequency Response check does not meet the specifications of steps h and k, refer to Paragraph 5-17 for Adjustment and Calibration procedures.

NOTE

The above procedure assumes that the Thermal Converter is perfectly flat over the frequency range used. Any deviations in the Thermal Converter calibration chart should be subtracted from the reading obtained in the 313A frequency response curve.

5-14. ATTENUATOR ACCURACY CHECK.

a. Connect the 313A, 312A, 461A, and substitution attenuators as shown in Figure 5-3.

b. Set the 313A controls as follows:

OSCILLATOR MODE . . . . TRACK 312A
METER MODE . . . . . 312A EXPAND
ATTENUATORS 00.0
MAX OUTPUT . . . . . +10 DBM

c. Set the 10 dB/step substitution attenuator to 90 and the 1 dB/step substitution attenuator to 0.

d. Set the 312A controls as follows:

FREQUENCY . . . . . 1000.00 kHz
REFERENCE LEVEL. . . . . -40 DBM
AMPLITUDE RANGE 0
RECEIVER MODE . . . . . AM
BANDWIDTH . . . . . 3000 Hz

e. Set the 461A Amplifier GAIN switch to 40 dB and adjust the 313A SCALE OFFSET so that the 313A meter reads 0.0.

f. Perform the attenuator checks listed in Table 5-2 with the 313A attenuators and the substitution attenuators set as indicated.

NOTE

In the following attenuator checks, it is assumed that the substitution attenuators are perfectly flat over the frequency range used. If there are any variations in the response of the substitution attenuators in the frequency range of 10 kHz to 22 MHz, these deviations must be considered when checking the 313A attenuators.

g. Remove the 461A amplifier from the test setup and connect the output of the substitution attenuators directly to the 312A input. Change the 10 dB/step substitution attenuator to zero.

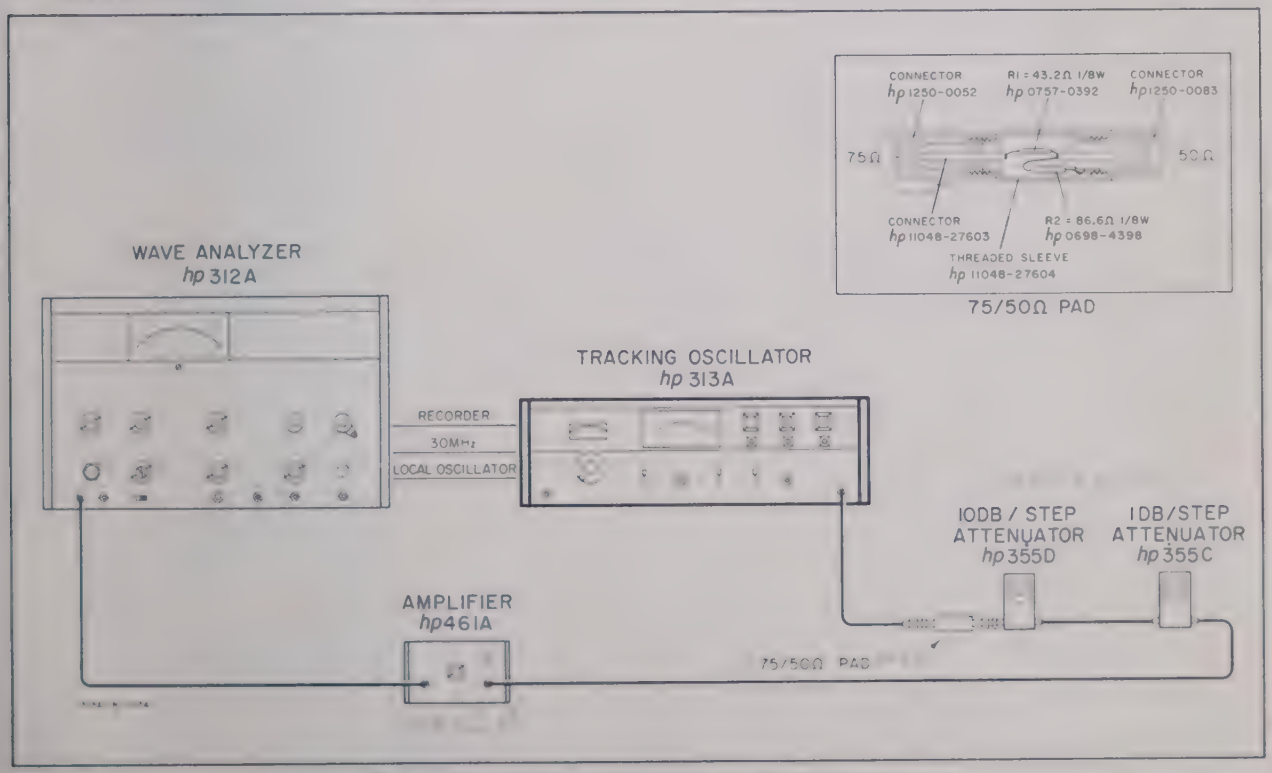


Figure 5-3. Attenuator Accuracy Test Setup

Table 5-2. 10 dB Step Attenuator Check

313A ATTENUATORS	SUBSTITUTION ATTENUATOR		313A METER INDICATION
	10 dB/Step	1 dB/Step	
00.0	90	0	0.0
10.0	80	0	0.0 ±0.1 dB
20.0	70	0	0.0 ±0.1 dB
30.0	60	0	0.0 ±0.1 dB
40.0	50	0	0.0 ±0.1 dB
50.0	40	0	0.0 ±0.1 dB
60.0	30	0	0.0 ±0.2 dB
70.0	20	0	0.0 ±0.2 dB
80.0	10	0	0.0 ±0.2 dB
90.0	0	0	0.0 ±0.2 dB

h. Change the 312A REFERENCE LEVEL to 0 DBM. Return the 313A attenuators to 00.0 and the 1 dB/step substitution attenuator to 10 dB. Adjust the 313A SCALE OFFSET for 0.0 on the 313A meter and perform the attenuator checks listed in Table 5-3.

i. Set the 313 attenuators to 00.0, the 10 dB/step substitution attenuator to 0dB and the 1 dB/step substitution attenuator to 10. Use the 313A SCALE OFFSET controls to set the 313A meter to 0.0 and perform the checks listed in Table 5-4.

Table 5-3. 1 dB Step Attenuator Check

313A ATTENUATORS	SUBSTITUTION ATTENUATOR		313A METER INDICATION
	10 dB/Step	1 dB/Step	
00.0	0	10	0.0
01.0	0	9	0.0 ±0.1 dB
02.0	0	8	0.0 ±0.1 dB
03.0	0	7	0.0 ±0.1 dB
04.0	0	6	0.0 ±0.1 dB
05.0	0	5	0.0 ±0.1 dB
06.0	0	4	0.0 ±0.1 dB
07.0	0	3	0.0 ±0.1 dB
08.0	0	2	0.0 ±0.1 dB
09.0	0	1	0.0 ±0.1 dB

Table 5-4. 0.1 dB Step Attenuator Check

313A ATTENUATORS	SUBSTITUTION ATTENUATOR		313A METER INDICATION
	10 dB/Step	1 dB/Step	
00.0	0	10	0.0
00.1	0	10	-0.1 ±.02 dB
00.2	0	10	-0.2 ±.02 dB
00.3	0	10	-0.3 ±.02 dB
00.4	0	10	-0.4 ±.02 dB
00.5	0	10	-0.5 ±.02 dB
00.6	0	10	-0.6 ±.02 dB
00.7	0	10	-0.7 ±.02 dB
00.8	0	10	-0.8 ±.02 dB
00.9	0	10	-0.9 ±.02 dB

j. Repeat steps a through i with the 312A frequency set to 10 kHz and again with the frequency set to 18 MHz. (If H01-312A is available, check at 22 MHz).

5-15. NON-HARMONIC DISTORTION CHECK.

a. Interconnect the Model 313A and Model 312A as follows:

Connect the 313A

RECORDER INPUT
LOCAL OSCILLATOR INPUT
30 MHz INPUT

To the 312A

RECORDER OUTPUT
LOCAL OSCILLATOR OUTPUT
30 MHz OUTPUT

b. Set the 313A and 312A controls as follows:

313A Controls

OSCILLATOR MODE . . . . TRACK 312A
METER MODE . . . . . OUTPUT MONITOR
MAX OUTPUT . . . . . + 10 DBM
ATTENUATORS 00.0

312A Controls

REFERENCE LEVEL . . . +10
AMPLITUDE RANGE . . . 0
FREQUENCY RANGE . . . 0
FREQUENCY . . . . . 20 kHz
INPUT MODE . . . . . TERMINATED, UNBALANCED
IMPEDANCE 75
RECEIVER MODE . . . . . AM

USE SPECTRUM ANALYZER

c. Connect the output of the 313A to the input of the Model 302A Wave Analyzer using a 75 ohm cable terminated in 75 ohms at the Wave Analyzer end of the cable.

d. Set the 302A controls as follows:

MAX INPUT LEVEL . . . . . 1 VOLT
RANGE . . . . . 0 DB
SCALE VALUE . . . . . ABSOLUTE
MODE SELECTOR . . . . . NORM

e. Tune the 302A FREQUENCY control for a maximum reading on the 302A at approximately 20 kHz. This is the fundamental frequency output of the 313A. The 302A meter should read 0.866 V (0.707 Option 01) at the maximum. Note the 302A frequency dial reading.

f. Tune the 302A up 35 Hz. Turn the 302A RANGE switch down as required for an indication on the 302A meter.

g. Tune the 302A very carefully for a maximum reading on the meter. The signal 35 Hz above the fundamental frequency must be more than 40 dB below the fundamental frequency in step e.

h. Tune the 302A up another 35 Hz to 70 Hz above the fundamental frequency. Tune carefully for a peak on the 302A meter. The signal 70 Hz above the fundamental frequency must be more than 40 dB below the fundamental frequency.

i. Using the above described procedure, check the signals 105, 140, 175 and 245 Hz above the fundamental frequency. These signals must be more than 40 dB below the fundamental frequency.

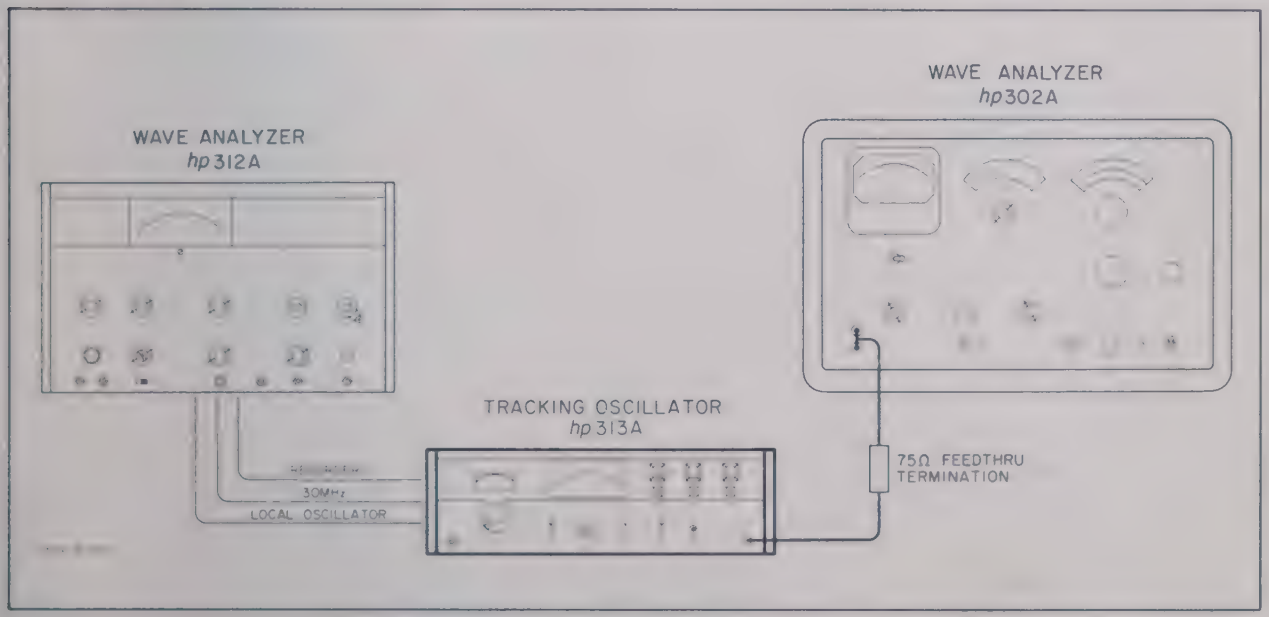


Figure 5-4. Non-Harmonic Distortion Test Setup

j. Check the signals at 35 Hz and 70 Hz below the fundamental frequency. These signals must be more than 40 dB below the fundamental frequency.

k. Check the signals at 105 Hz, 140 Hz, 175 Hz and 245 Hz below the fundamental frequency. These signals must be more than 40 dB below the fundamental frequency.

l. Using a 75Ω feedthru, connect the 313A output to the input of the 5245L electronic counter. Set the 312A frequency to read 1000.00 kHz. The counter should read 1000.03 or 1000.04.

m. If the Non-Harmonic Distortion Check does not meet the specifications of steps e through l, refer to Paragraph 5-17 for Adjustment and Calibration procedures.

5-16. HARMONIC DISTORTION CHECK.

a. Connect the 313A, 3406A, 1 MHz Distortion Filter and 75 ohm feedthru termination as shown in Figure 5-5.

b. Set the 313A controls as follows:

OSCILLATOR MODE . . . . . INTERNAL
ATTENUATORS. 00.0
MAX OUTPUT . . . . . +10 DBM
Frequency Dial . . . . . 5 MHz

c. Set the 3406A to the +10 DBM range and note the reading.

d. Slowly tune the 313A frequency down to 1 MHz noting the dip in the 3406A meter reading.

e. Change the 3406A RANGE switch as required and very carefully tune the 313A frequency dial for a maximum dip on the 3406A meter. This dip must be down at least 34 dBm from the value noted in step c.

f. Substitute the 9.5 MHz Distortion Filter for the 1 MHz Distortion Filter in Figure 5-5.

g. Tune the 313A frequency to 5 MHz and note the reference reading on the 3406A in dBm.

h. Tune the 313A frequency dial very carefully for a maximum dip at 9.5 MHz and note the reading on the 3406A. This reading must be down at least 34 dBm from the reading obtained in step g.

i. Replace the 9.5 MHz Distortion Filter in Figure 5-5 with the 20.5 MHz Distortion Filter.

j. Tune the 313A frequency dial to 8 MHz and note the reference reading on the 3406A.

k. Tune the 313A frequency dial to 20.5 MHz and very carefully adjust the frequency for a maximum dip on the 3406A. The 3406A reading must be down at least 34 dBm from the reading obtained in step j.

5-17. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-18. The following is a complete adjustment and calibration procedure for the 313A which should be performed only after it has been determined by the Performance Checks that the 313A is not within specifications. Refer to Figures 5-6 and 5-7 for location of internal adjustments.

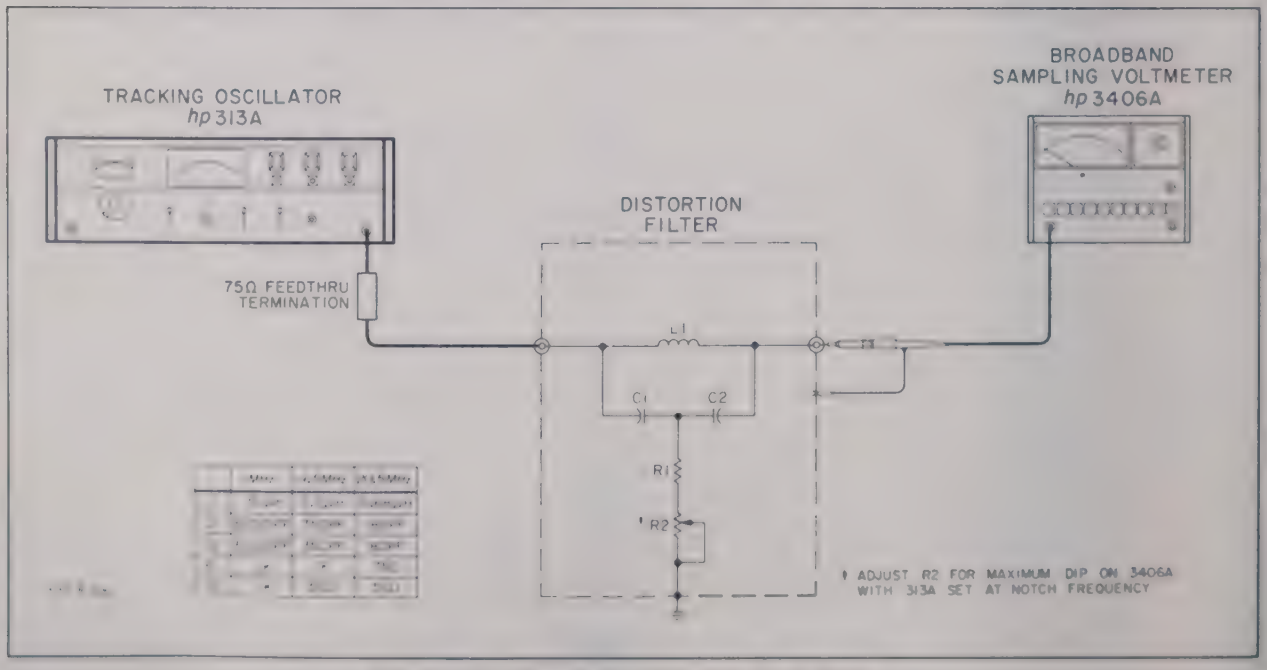
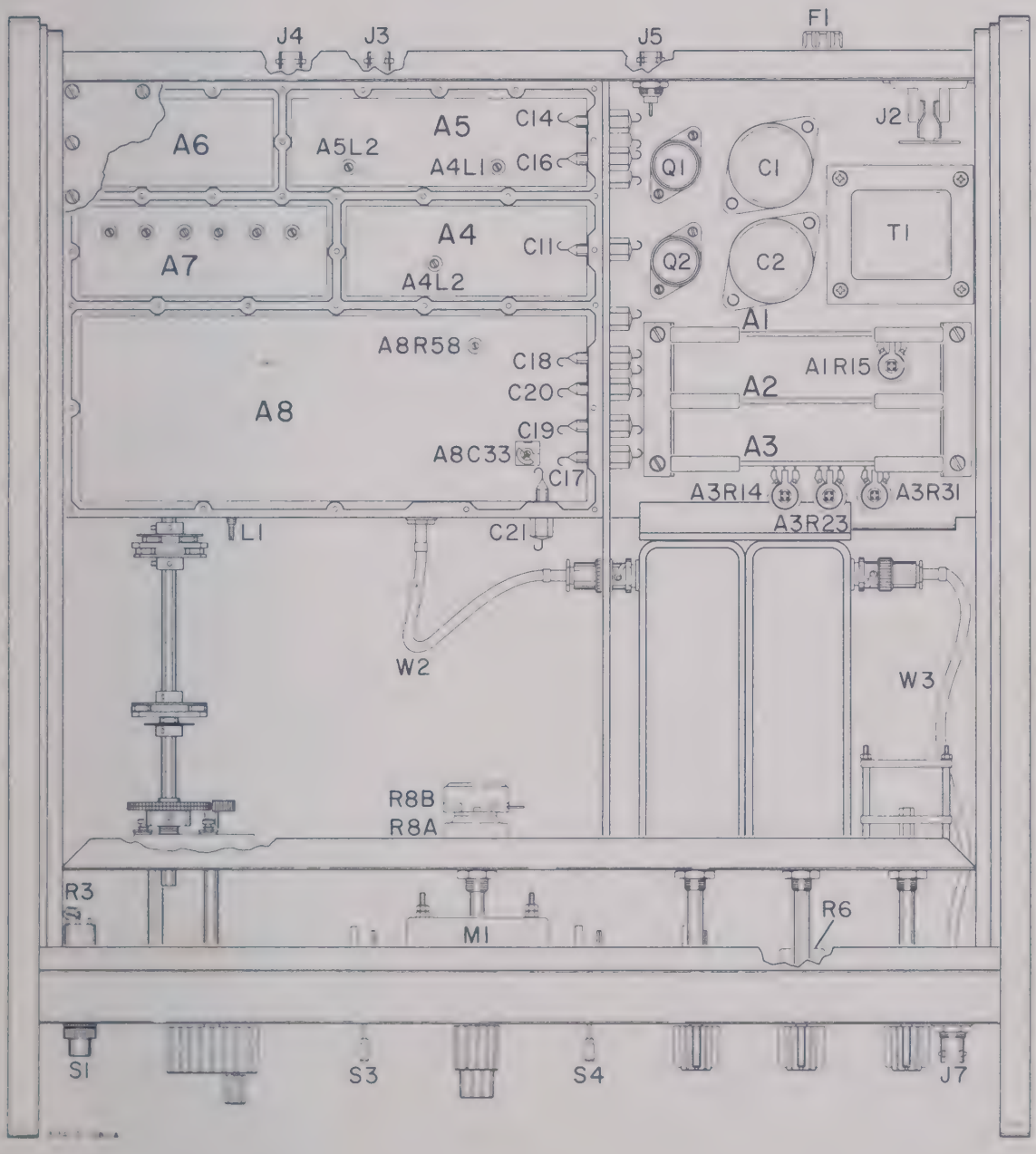


Figure 5-5. Harmonic Distortion Test Setup



TOP VIEW

Figure 5-6. Component Location, Top View

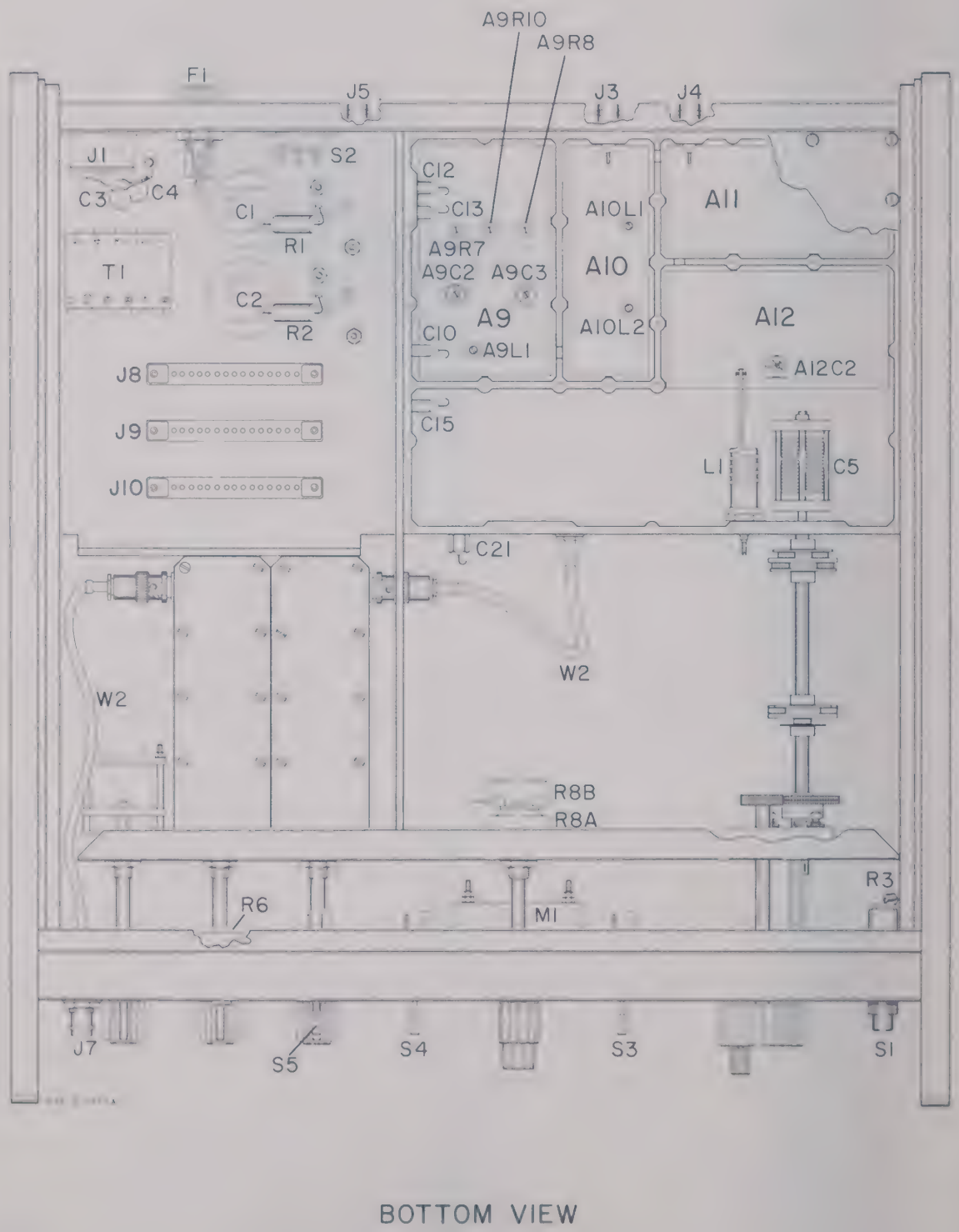


Figure 5-7. Component Location, Bottom View

5-19. COVER REMOVAL.

5-20. To remove the top or bottom cover, remove the retaining screws from the sides of the cover, slide the cover about 1/2 inch to the rear and lift if off. To replace the cover, reverse this procedure.

5-21. To remove the side covers, remove the retaining screws in the cover and lift it off.

5-22. POWER SUPPLY VOLTAGE ADJUSTMENT.

a. Set the Model 3440A/3444A Voltmeter to the 100 V DC range and connect between pin 3 of J8 and ground.

b. Turn on the Model 313A and adjust A1R15 for exactly -20 volts.

c. Connect the 3440A/3444A between J8 pin 1 and ground. The positive supply must be +20 volts and ± 0.2 volts.

d. If the positive supply is not within the limits specified in step c, the value of A1R7 can be changed to bring the voltage into the proper range. Change the value of A1R7 approximately 30Ω/0.1 volt of change needed. If the voltage is too high, increase the value of A1R7 and if the voltage is too low, decrease the value of A1R7.

5-23. INTERNAL ADJUSTMENTS.

a. Connect the 313A output to the 175A/1752B oscilloscope through a 75Ω cable and a 75Ω feedthru termination.

b. Set the 313A controls as follows:

OSCILLATOR MODE . . . INTERNAL
FREQUENCY . . . . . 1 MHz
METER MODE . . . . . OUTPUT MONITOR
MAX OUTPUT . . . . . +10 DB
ATTENUATORS 00.0

c. Adjust the oscilloscope controls for 10 stable cycles in 10 cm of horizontal deflection.

d. Set the Model 3440A/3444A Digital Voltmeter to the 10 V range and connect between C16 on the RF casting and ground.

e. Turn on the Model 313A and adjust A4L2, A5L1 and A5L2 for maximum signal on the oscilloscope screen. The signal should be at least 2 volts peak-to-peak in amplitude.

f. Readjust A5L1 and A5L2 for minimum reading on the digital voltmeter. This reading should be between +0.5 and +1.0 volts.

g. Adjust the SWEEP TIME on the oscilloscope as necessary to check the waveform envelope. There should be no amplitude variations in the envelope.

h. Connect a 10:1 oscilloscope probe between pin 4 of J9 and ground. The waveform should be a sine wave 0.7 ± .1 volt peak-to-peak in amplitude.

i. Connect the 10:1 oscilloscope probe to pin 13 of J9. The waveform should be 0.7 ± 0.1 V peak-to-peak in amplitude.

j. Connect the input of 5245L counter between pin 4 of J9 and set counter to frequency. The frequency indicated on 5245L must be 35 ± 3 Hz.

5-24. OUTPUT CALIBRATION.

a. Remove the grounding strap from the input terminals of the 3440A/3444A so that a floating measurement can be made.

b. Set the 3440A/3444A range switch to 10 V and connect across A3TP1 and A3TP2.

c. Adjust A3R31 (meter cal) for a reading of 1.197 ± .002 V on the 3440A/3444A.

d. If A3R31 has insufficient range for the adjustment, the value of A3R26 may be changed to bring the control into the correct range. If the voltmeter reads low, lower the value of A3R26 by 1000Ω. If the voltmeter reads high, raise the value of A3R26 by 1000Ω.

e. Connect the 3440A/3444A between A3TP3 and ground.

f. Adjust A3R14 (AGC reference level) to obtain 5.80 ± .01 V on the 3440A/3444A.

g. Set the 400F Voltmeter to the 1 V range and connect to the 313A output using RG-59B/U cable and a 75Ω feedthru termination at the voltmeter end of the cable. (Use a 50Ω termination and RG-58C/U cable for Option 01 instruments.)

h. Adjust the 313A OUTPUT CAL control R6 so that the meter reads directly over the CAL mark on the 313A meter face.

i. If the meter is less than full scale at full clockwise rotation of the OUTPUT CAL control, reduce the value of A3R1 by 250Ω and repeat step h. If the meter is greater than full scale at full counterclockwise rotation of the OUTPUT CAL control, raise the value of A3R1 by 250Ω and repeat step h.

j. Adjust A8R58 (detector gain) so that the 400F reads exactly 0.866 volts. (For Option 01 instruments, adjust A8R58 for 0.707 volts.)

k. If the 400F reads below the calibration point with A8R58 at maximum counterclockwise rotation, increase the value of A8R49 by the percentage that the output voltage is low with A8R58 centered. If the 400F reads above the calibration point with A8R58 at maximum clockwise rotation, decrease the value of A8R49 by the percentage that the output voltage is high with A8R58 centered.

5-25. FREQUENCY DIAL CALIBRATION.

a. Connect the Model 5245L electronic counter to the output of the 313A using an RG-59B/U cable and a 75Ω feedthru termination at the counter end of the cable.

b. Set the electronic counter to read frequency.

c. Turn the 313A frequency knob clockwise until the stop is felt.

d. Loosen the set screws securing the dial hub to the ball drive mechanism and rotate the frequency dial until the alignment dot to the left of zero is directly under the mark in the dial window. Retighten the screws.

e. Loosen the set screws in the straight coupler connecting the gear mechanism to the long tuning shaft.

f. Remove the cover from the bottom of the RF casting and turn the tuning capacitor plates until they are fully meshed (maximum capacitance). Retighten the set screws using care not to disturb the previous adjustment.

g. Turn the frequency dial until 0 appears directly under the window index marker.

h. Adjust L1 (located on front of RF casting) to obtain a reading of less than 10 kHz on the electronic counter.

i. Set the frequency dial to 22 MHz and adjust A12C2 to obtain a reading of 22 MHz ± 10 kHz on the counter.

j. Repeat steps h and i until the error at both ends of the dial is less than 10 kHz.

k. If the frequency reads too high in step i and turning A12C2 to maximum capacitance does not bring the frequency down to 22 MHz, remove the RF casting bottom cover and increase the value of A12C1 by 5 pF. If the frequency in step i reads too low and turning A12C2 to minimum capacitance fails to bring the frequency up to 22 MHz, decrease the value of A12C1 by 5 pF. Replace the bottom cover and perform steps h and i again.

l. Use the electronic counter to check the 313A frequency dial accuracy between 10 kHz and 22 MHz. The dial and counter must agree within the limits specified in Paragraph 5-10.

5-26. NON-HARMONIC DISTORTION ADJUSTMENT.

a. Interconnect the 313A and 312A as follows:

Connect the 313A

RECORDER INPUT
LOCAL OSCILLATOR INPUT
30 MHz INPUT

To the 312A

RECORDER OUTPUT
LOCAL OSCILLATOR OUTPUT
30 MHz OUTPUT

b. Set the 313A and 312A controls as follows:

313A

OSCILLATOR MODE . . . TRACK 312A
METER MODE . . . . . OUTPUT MONITOR
MAX OUTPUT . . . . . +10 DBM
ATTENUATORS 00.0
Frequency Dial . . . . . 1 MHz

312A

REFERENCE LEVEL. . . +10
AMPLITUDE RANGE. . . 0
FREQUENCY RANGE. . . 0
FREQUENCY . . . . . 20 kHz
RECEIVER MODE . . . . AM

c. Connect the 10:1 oscilloscope probe between A10TP1 and ground and adjust the oscilloscope controls for a stable presentation of the signal.

d. Adjust A10L1 and A10L2 for maximum deflection on the oscilloscope. The minimum level should be 4 volts peak-to-peak.

e. Connect the output of the 313A to the input terminals of the 302A Wave Analyzer using an RF-59B/U cable terminated in 75Ω at the 302A end of the cable. (Use 50Ω cable and 50Ω termination for all Option 01 instruments.

f. Set the 302A controls as follows:

MAX INPUT LEVEL . . . . . 1 VOLT
RANGE . . . . . 0 DB
SCALE VALUE . . . . . ABSOLUTE
MODE SELECTOR . . . . . NORMAL

g. Tune the 302A Frequency control to approximately 20 kHz to find the fundamental output frequency of the 313A. The 302A meter should indicate 0.866 (+ 10 dBm) (0.707 Option 01) maximum. Note the reading on the 302A Frequency dial.

h. Tune the 302A up in frequency by 35 Hz.

i. Turn the 302A RANGE switch down as required for a display on the 302A meter.

j. Tune the 302A very carefully for a maximum reading making certain that the signal monitored is 35 Hz above the frequency noted in step g.

k. Adjust A9R7 and A9R8 (carrier balance) alternately for a minimum reading on the 302A meter, turning down the range switch as necessary for additional sensitivity.

l. Tune the 302A up another 35 Hz (70 Hz above the fundamental) for maximum reading on the 302A meter.

m. Adjust A9R10, A9C2, A9C3 and A9L1 (sideband balance) alternately for a minimum reading on the 302A meter.

n. Repeat steps g through m several times until the signals 35 Hz and 70 Hz above the fundamental frequency are both more than 40 dB below the fundamental frequency.

o. Using the procedure outlined in steps g through j, check the signals at 35 Hz and 70 Hz below the fundamental frequency. These signals must be at least 40 dB below the fundamental frequency.

p. Tune the 302A 105 Hz above the fundamental frequency and measure the amplitude of the signal. The amplitude must be more than 40 dB below the fundamental frequency. If after adjustments have been made, the non-harmonic distortion check is out of tolerance, the value of A2R11 may be changed. In most cases A2R11 will have to be increased in value in order to increase the amplitude of the 35 Hz signal.

q. Tune the 302A 140 Hz above the fundamental frequency and measure the amplitude of the signal. The amplitude must be more than 40 dB below the fundamental frequency.

r. Check the signals at 105 Hz and 140 Hz below the fundamental frequency. These signals must also be more than 40 dB below the fundamental frequency.

s. If the Non-Harmonic Distortion Adjustment cannot be performed to meet specifications, it may be necessary to change the value of A2R11. To select the correct value of A2R11, connect an oscilloscope to either A2 pin 4 or A2 pin 13 and change the value of A2R11 until the observed waveform on the oscilloscope is between 0.5 and 0.9 volts peak-to-peak. To increase the amplitude of this signal, increase the value of A2R11. If the value of A2R11 is changed, repeat steps a through r.

t. Set the digital voltmeter range switch to 10 V and connect between C16 on the RF casting and ground. The meter should indicate less than +1.0 V.

u. Connect the output of the 313A to the input of the 5245L electronic counter using a 75Ω cable and 75Ω termination (50Ω cable and termination for Option 01 instruments). Set the 312A frequency to read 1000.00 kHz. The counter should indicate 10000.04 or 10000.03. If the counter reads 9999.97 or 9999.96, interchange the leads on C12 and C13 on the RF casting and repeat e through s.

5-27. METER EXPAND AND TRACKING.

a. Connect the 313A, the Meter Expand Test Set and the 1 DB/step substitution attenuator as shown in Figure 5-1.

b. Connect the digital voltmeter to the test point on the Meter Expand Test Set and adjust the voltage control on the test set for a reading of 1.000 volts on the digital voltmeter. Turn the substitution attenuator to 4 dB.

c. Adjust the 313A SCALE OFFSET controls so that the 313A meter reads +1.0 DB.

d. Turn the substitution attenuator to 6 dB. If the 313A meter reads below -1.0 dB, adjust A3R23 (expand tracking) until the meter reads as much above -1.0 as it previously read below -1.0 dB. If the 313A meter reads above -1.0 dB, adjust A3R23 until the meter reads as much below -1.0 dB as it previously read above -1.0.

e. Turn the substitution attenuator to 4 dB and readjust the 313A SCALE OFFSET controls for a meter reading of +1.0 dB.

f. Repeat steps b through e several times until no error exists at either end of the scale.

g. Turn the substitution attenuator to 0dB. Turn the 313A SCALE OFFSET Coarse control full CCW with the Fine control centered. The 313A meter should read 0.0 or less.

h. Adjust the 313A SCALE OFFSET controls so that the 313A meter reads +1.0 dB. Turn the substitution attenuator control to 2 dB. The 313A meter should read -1.0 dB ± 0.02 dB.

i. Readjust the 313A SCALE OFFSET controls so that the 313A meter reads +1.0 dB and repeat steps h, through 10 dB of attenuation.

j. Turn the 313A SCALE OFFSET Coarse Control full CW with the Fine control centered. The 313A meter must read 0.0 or greater.

5-28. FREQUENCY RESPONSE ADJUSTMENT.

a. Connect the 313A, 312A, 419A Voltmeter, H01-11050A Thermal Converter and Bucking Supply as shown in Figure 5-2.

b. Set the 313A controls as follows:

OSCILLATOR MODE . . . TRACK 312A
METER MODE . . . . . OUTPUT MONITOR
MAX OUTPUT . . . . . +10 DBM
ATTENUATORS 00.0

c. Set the 312A frequency to 10 kHz with the variable frequency control and the FREQUENCY RANGE switch set to 0.

d. Set the 419A to the 10 mV range and the Bucking Supply to OFF. Push the VM button on the 419A. The 419A should read between 6 and 8 millivolts.

e. Turn ON the Bucking Supply and adjust the controls for a null on the 419A.

f. Turn the 419A RANGE switch to the 300 μV range and if necessary, readjust the Bucking Supply controls for a null on the 419A.

g. Turn the 313A 0.1 dB attenuator one step CCW and note the 419A reading. This represents 0.1 dB deviation for the following check. Return the attenuator to zero.

h. Tune the 312A slowly between 10 kHz and 18 MHz (for H01-312A, tune between 10 kHz and 22 MHz) noting any deviations in the 419A meter. Any deviations should not exceed the value noted in step g.

i. Switch the 313A OSCILLATOR MODE switch to INTERNAL and slowly tune the 313A from 1 kHz to 22 MHz noting any deviations on the 419A meter. Any deviations should not exceed the value recorded in step g.

j. With the 313A frequency set to 22 MHz, adjust A8C33 (frequency response) for zero on the 419A meter and repeat steps a through i.

k. If necessary, A8C33 may be readjusted to meet the limits of steps f and i. If A8C33 has insufficient range to meet the limits of steps f and i A8C26 may be changed. If the limits cannot be met due to A8C33 reaching its minimum capacitance setting, increase the value of A8C26 approximately 3 picofarads and again perform step f through i. If the limits cannot be reached due to A8C33 reaching minimum capacitance setting, decrease the value of A8C26 by 3 picofarads and again perform steps f through i.

NOTE

The above procedure assumes that the Thermal Converter is perfectly flat over the frequency range used. If the calibration chart accompanying the Thermal Converter shows any deviations greater than 0.25% over the frequency range of 10 kHz to 22 MHz, this deviation must be subtracted from the deviations noted in the 313A output response curve.

l. Change the 313A attenuators to 11.1 and the output frequency to 1 MHz.

m. Change both the 419A and bucking supply to the 1 mV range and adjust the bucking supply for a null on the 419A meter.

n. Tune the 313A slowly from 1 MHz to 22 MHz noting any deviations on the 419A meter. Any deviations should not exceed the value noted in step g.

o. If the 419A indication at the high end exceeds the value noted in step g increase A8C37 by 5 pF and repeat steps l through n. If the 419A indicates high decrease A8C37 by 5 pF and again perform steps l through n.

p. Set the 313A output frequency to 1 MHz. Change the 313A 10 dB step attenuator to zero and at the same time change the MAX OUTPUT switch to 0 DBM. If necessary, readjust the bucking supply for a zero indication on the 419A meter.

q. Tune the 313A from 1 MHz to 22 MHz, noting any deviations on the 419A meter. The 419A should not deviate more than the value noted in step g.

r. If the 419A exceeds the value noted in step g (1% deviation) increase A8C38 to lower the 419A indication in the middle of the band and increase the value of A8R59 to bring up the response on the high end of the band.

5-29. TROUBLESHOOTING.

5-30. The following procedures are designed to aid the user in locating malfunctions in the Model 313A in a minimum of time. Included is a troubleshooting tree which, if followed in numerical sequence, should reduce the time required to isolate the malfunction to a particular block (See Figure 5-12).

5-31. If should first be determined by the Performance Checks (Paragraph 5-8) or the Adjustment and Calibration procedures (Paragraph 5-17) that a malfunction does exist. Once this has been determined, visually inspect the instrument for loose wires, burned or shorted components and possibly any foreign matter such as nuts, screws and washers that might have become trapped inside the instrument. If no defect can be found visually, continue with the following procedures.

5-32. PROCEDURE.

5-33. Since the 313A has two modes of operation, the malfunction can readily be isolated to one of three areas. Table 5-5 and Figure 5-10 will help to isolate the malfunction to a particular area.

Table 5-5. Area Troubleshooting

MODE	OUTPUT NORMAL AT J7 (0.866 V rms into 75Ω)	TROUBLE AREA
INTERNAL TRACK 312A	YES NO	#1
INTERNAL TRACK 312A	NO YES	#2
INTERNAL TRACK 312A	NO NO	#3

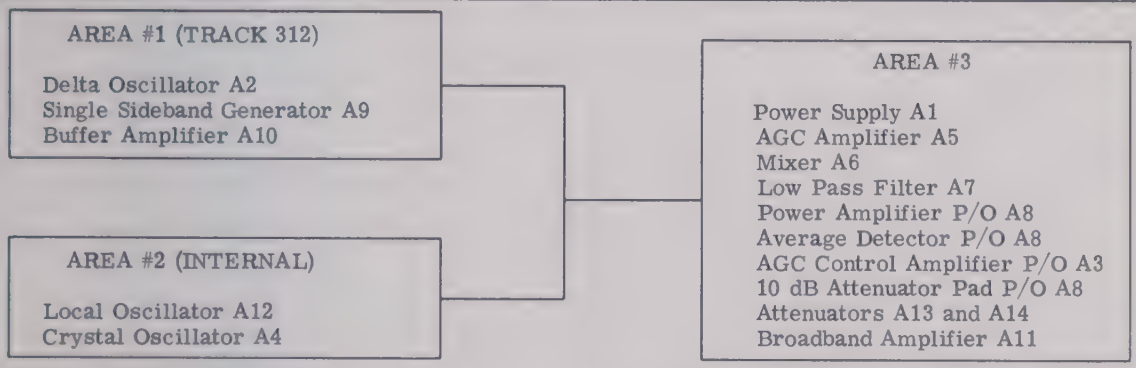


Figure 5-8. Area Troubleshooting

5-34. The Troubleshooting Tree (Figure 5-10) when used in conjunction with the functional block diagram (Figure 7-3) and schematic diagrams (Figure 7-4 through 7-9) will greatly simplify troubleshooting the Model 313A. To use the troubleshooting tree, begin at (1) and continue in numerical sequence according to the results (true or false) of the checks indicated on the troubleshooting tree. If any test fails refer to the schematic diagrams and utilize the voltage levels to aid in determining the cause of failure.

5-35. Check the AGC voltage at C16 on the RF casting. If the AGC voltage is abnormal (+0.5 to +1 volt is normal) disconnect the lead from C16 and substitute an external AGC voltage while troubleshooting the closed loop (See Figure 5-9). Adjust the potentiometer R1 for approximately 0.7 volts.

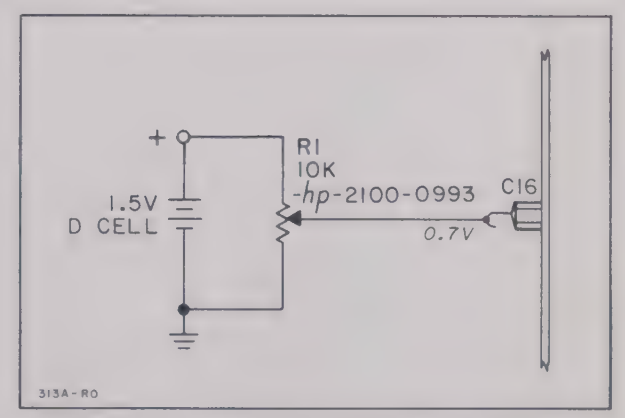


Figure 5-9. AGC Substitution Test Setup

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model: 313A
Tracking Oscillator
Serial No. _____

Tests Performed by: _____
Date _____

DESCRIPTION	CHECK
1. DIAL ACCURACY CHECK	
a. 1 MHz	_____ 1 MHz ± 220 kHz
b. 2 MHz	_____ 2 MHz ± 220 kHz
2. OUTPUT MONITOR CHECK	_____ 0.866 V ± 0.008 V
3. METER EXPAND AND TRACKING	
a. + 1 dB	_____ +1 dB ± 0.05 dB
b. -1 dB	_____ - 1 dB ± 0.05 dB
4. OUTPUT FREQUENCY RESPONSE CHECK	
a. Track 312A Mode, + 10 dBm	_____ > ± 0.1 dB deviation
b. Internal Mode, +10 dBm	_____ > ± 0.1 dB deviation
c. Internal Mode, 0 dBm	_____ > ± 0.1 dB deviation
5. ATTENUATOR ACCURACY CHECK	
a. 10 dB Attenuator	
(1) 00.0 dB	_____ 0.0 (Reference)
(2) 10.0 dB	_____ 0.0 ± 0.1 dB
(3) 20.0 dB	_____ 0.0 ± 0.1 dB
(4) 30.0 dB	_____ 0.0 ± 0.1 dB
(5) 40.0 dB	_____ 0.0 ± 0.1 dB
(6) 50.0 dB	_____ 0.0 ± 0.1 dB
(7) 60.0 dB	_____ 0.0 ± 0.2 dB
(8) 70.0 dB	_____ 0.0 ± 0.2 dB
(9) 80.0 dB	_____ 0.0 ± 0.2 dB
(10) 90.0 dB	_____ 0.0 ± 0.2 dB
b. 1 dB Attenuator	
(1) 00.0 dB	_____ 0.0 (Reference)
(2) 01.0 dB	_____ 0.0 ± 0.1 dB
(3) 02.0 dB	_____ 0.0 ± 0.1 dB
(4) 03.0 dB	_____ 0.0 ± 0.1 dB
(5) 04.0 dB	_____ 0.0 ± 0.1 dB
(6) 05.0 dB	_____ 0.0 ± 0.1 dB
(7) 06.0 dB	_____ 0.0 ± 0.1 dB
(8) 07.0 dB	_____ 0.0 ± 0.1 dB
(9) 08.0 dB	_____ 0.0 ± 0.1 dB
(10) 09.0 dB	_____ 0.0 ± 0.1 dB
c. 0.1 dB Attenuator	
(1) 00.0 dB	_____ 0.0 (Reference)
(2) 00.1 dB	_____ 0.1 ± 0.02 dB
(3) 00.2 dB	_____ 0.2 ± 0.02 dB
(4) 00.3 dB	_____ 0.3 ± 0.02 dB
(5) 00.4 dB	_____ 0.4 ± 0.02 dB
(6) 00.5 dB	_____ 0.5 ± 0.02 dB
(7) 00.6 dB	_____ 0.6 ± 0.02 dB
(8) 00.7 dB	_____ 0.7 ± 0.02 dB
(9) 00.8 dB	_____ 0.8 ± 0.02 dB
(10) 00.9 dB	_____ 0.9 ± 0.02 dB

DESCRIPTION	CHECK
6. NON-HARMONIC DISTORTION CHECK	
a. Distortion	
(1) 20 kHz	(Reference)
(2) 20 kHz + 35 Hz	_____ Down > 40 dB
(3) 20 kHz + 70 Hz	_____ Down > 40 dB
(4) 20 kHz + 105 Hz	_____ Down > 40 dB
(5) 20 kHz + 140 Hz	_____ Down > 40 dB
(6) 20 kHz + 175 Hz	_____ Down > 40 dB
(7) 20 kHz + 245 Hz	_____ Down > 40 dB
(8) 20 kHz - 35 Hz	_____ Down > 40 dB
(9) 20 kHz - 70 Hz	_____ Down > 40 dB
(10) 20 kHz - 105 Hz	_____ Down > 40 dB
(11) 20 kHz - 140 Hz	_____ Down > 40 dB
(12) 20 kHz - 175 Hz	_____ Down > 40 dB
(13) 20 kHz - 245 Hz	_____ Down > 40 dB
b. 312A Tuning	
1000.00 kHz	_____ 1000.03 or 1000.04 _____ Counter Indication
7. HARMONIC DISTORTION CHECK	
a. Tuning 1 MHz	_____ Down > 34 dB
b. Tuning 9.5 MHz	_____ Down > 34 dB
c. Tuning 20.5 MHz	_____ Down > 34 dB

NOTE

The voltage levels indicated on this troubleshooting tree are nominal values and may vary slightly from one instrument to another. Therefore the indicated values should be used for troubleshooting purposes only and not for adjustments. Use a 10:1 oscilloscope probe to prevent loading. An oscilloscope with a pass band of at least 30 MHz should be used.

Set the 313A controls as follows unless otherwise indicated in the troubleshooting tree.

OSCILLATOR MODE	INTERNAL
METER MODE	OUTPUT MONITOR
MAX OUTPUT	+ 10 dBm
ATTENUATORS	00.0
FREQUENCY DIAL	1 MHz

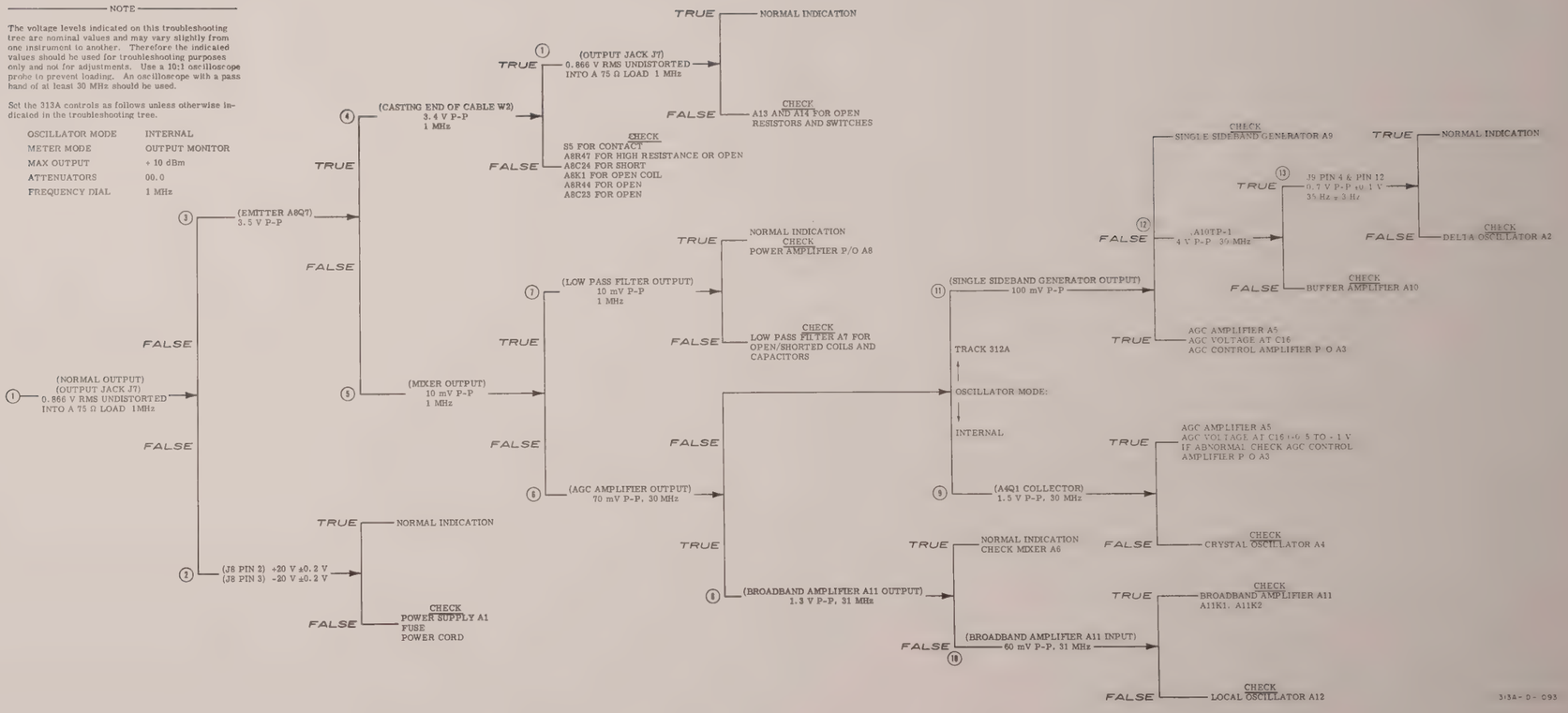


Figure 5-10. Troubleshooting Tree

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Manufacturer's part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

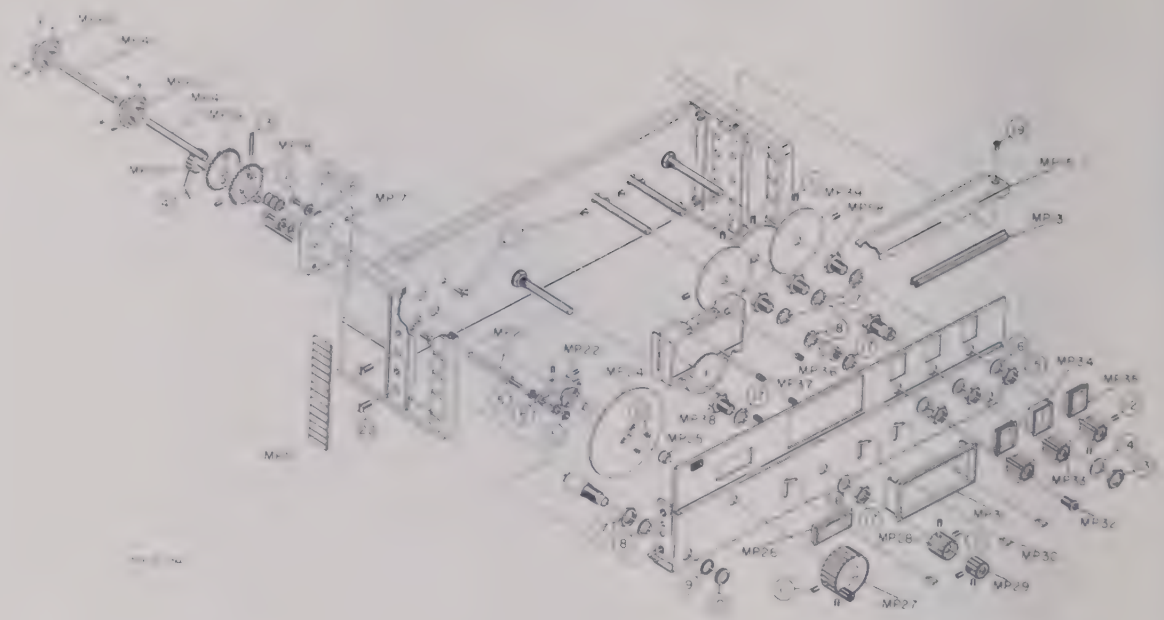
DESIGNATORS

A	= assembly	F	= fuse	MP	= mechanical part	TC	= thermocouple
B	= motor	FL	= filter	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
BT	= battery	HR	= heater	Q	= transistor	W	= cable
C	= capacitor	IC	= integrated circuit	QCR	= transistor-diode	X	= socket
CR	= diode	J	= jack	R	= resistor	XDS	= lampholder
DL	= delay line	K	= relay	RT	= thermistor	XF	= fuseholder
DS	= lamp	L	= inductor	S	= switch	Z	= network
E	= misc electronic part	M	= meter	T	= transformer		

ABBREVIATIONS

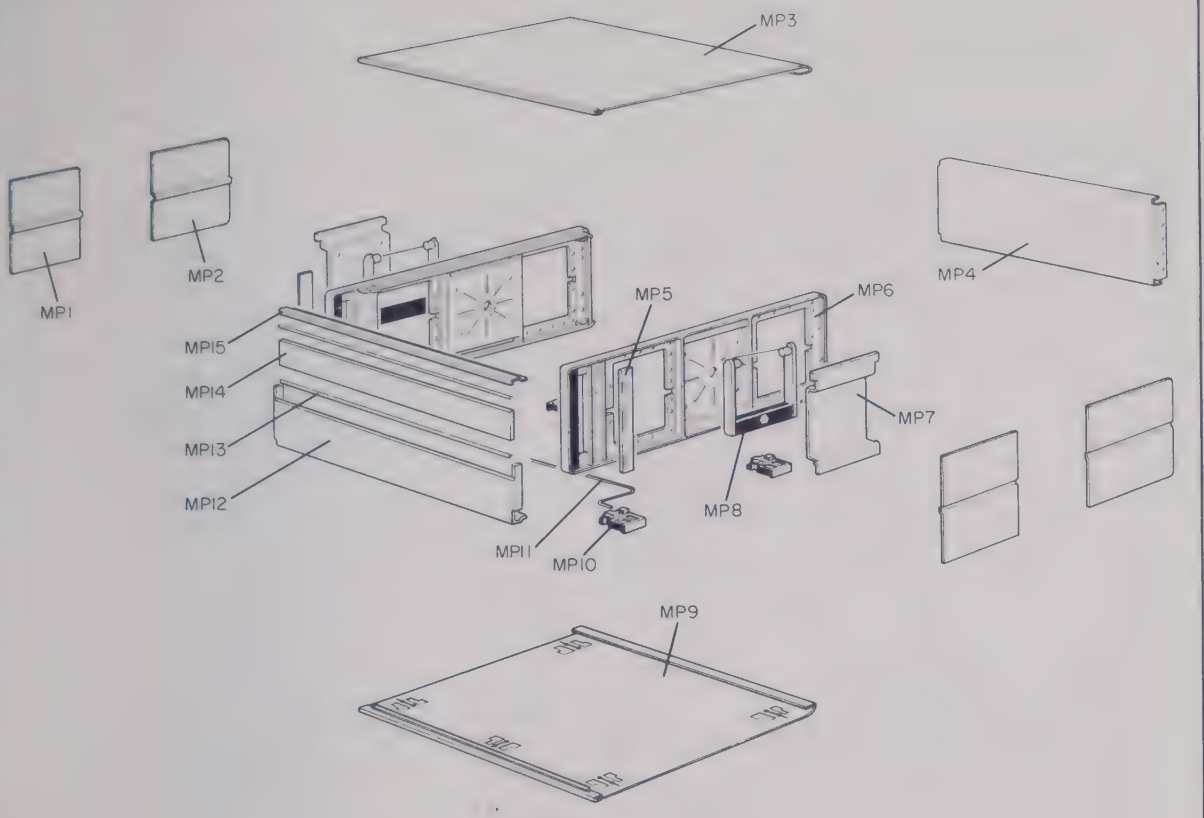
Ag	= silver	ID	= inside diameter	ns	= nanosecond (s) = 10^{-9} seconds	sl	= slide
Al	= aluminum	impg	= impregnated	nsr	= not separately replaceable	SPDT	= single-pole double-throw
A	= ampere (s)	incd	= incandescent			SPST	= single-pole single-throw
Au	= gold	ins	= insulation (ed)	Ω	= ohm (s)	Ta	= tantalum
C	= capacitor	kΩ	= kilohm (s) = 10^{+3} ohms	obd	= order by description	TC	= temperature coefficient
cer	= ceramic	kHz	= kilohertz = 10^{+3} hertz	OD	= outside diameter	TiO_2	= titanium dioxide
coef	= coefficient	L	= inductor	p	= peak	tog	= toggle
com	= common	lin	= linear taper	pc	= printed circuit	tol	= tolerance
comp	= composition	log	= logarithmic taper	pF	= picofarad (s) = 10^{-12} farads	trim	= trimmer
conn	= connection	m	= milli = 10^{-3}	piv	= peak inverse voltage	TSTR	= transistor
dep	= deposited	mA	= milliampere (s) = 10^{-3} amperes	p/o	= part of	V	= volt (s)
DPDT	= double-pole double-throw	MHz	= megahertz = 10^{+6} hertz	pos	= position (s)	vacw	= alternating current working voltage
DPST	= double-pole single-throw	MΩ	= megohm-(s) = 10^{+6} ohms	poly	= polystyrene	var	= variable
elect	= electrolytic	met film	= metal film	pot	= potentiometer	vdcw	= direct current working voltage
encap	= encapsulated	mfr	= manufacturer	p-p	= peak-to-peak	W	= watt (s)
F	= farad (s)	mtg	= mounting	ppm	= parts per million	w/	= with
FET	= field effect transistor	mV	= millivolt (s) = 10^{-3} volts	prec	= precision (temperature coefficient, long term stability, and/or tolerance)	wiv	= working inverse voltage
fxd	= fixed	μ	= micro = 10^{-6}			w/o	= without
GaAs	= gallium arsenide	μV	= microvolt (s) = 10^{-6} volts			ww	= wirewound
GHz	= gigahertz = 10^{+9} hertz	my	= Mylar ®	R	= resistor	*	= optimum value selected at factory, average value shown (part may be omitted)
gd	= guard (ed)	nA	= nanoampere (s) = 10^{-9} amperes	Rh	= rhodium	**	= no standard type number assigned (selected or special type)
Ge	= germanium	NC	= normally closed	rms	= root-mean-square		
grd	= ground (ed)	Ne	= neon	rot	= rotary		
H	= henry (ies)	NO	= normally open	Se	= selenium		
Hg	= mercury	NPO	= negative positive zero (zero temperature coefficient)	sect	= section (s)		
Hz	= hertz (cycle (s) per second)			Si	= silicon		

® Dupont de Nemours



DESCRIPTION	-hp- PART NO.
1. Screw	2390-0007
2. Screw	2380-0001
3. Screw; set	3030-0023
4. Spring; thrust	1460-0114
5. Nut	2260-0001
6. Washer; lock	2190-0001
7. Nut	0590-0038
8. Washer; lock	2190-0068
9. Nut Part of 3101-0100 Switch Assembly	
10. Nut Part of 3101-0100 Switch Assembly	
11. Screw; Set #8-32 x 3/16 Allen	3030-0001
12. Screw; Set #6-32 x 1/8 Allen	3030-0022
13. Nut	2950-0054
14. Washer; flat	3050-0064
15. Nut; 3/8 x 32	2950-0001
16. Washer; flat	3050-0067
17. Washer; 3/8"	2190-0016
18. Washer; 1/4" lock	2190-0027
19 Screw; #6-32	2370-0016
20. Screw; #8-32	2530-0011
21. Screw	0520-0018

Figure 6-1. Attaching Hardware



DESIGNATOR	DESCRIPTION	-hp- PART NO.
MP-1	Cover: side front	5000-0737
MP-2	Cover: side rear	5000-0736
MP-3	Cover: top	5060-0740
MP-4	Panel: rear	00313-00202
MP-5	Plate: fluted aluminum	5000-0051
MP-6	Frame	00313-24401
MP-7	Retainer: 4H handle	5060-0766
MP-8	Handle	5060-0763
MP-9	Cover: bottom	5060-0752
MP-10	Foot	5060-0767
MP-11	Stand: tilt	1490-0030
MP-12	Panel: front	00313-00201
MP-13	Strip: trim	5000-5835
MP-14	Panel: plate	00313-04301
MP-15	Strip: top front panel	5000-5836

Figure 6-2. Chassis and Cover Component Identification

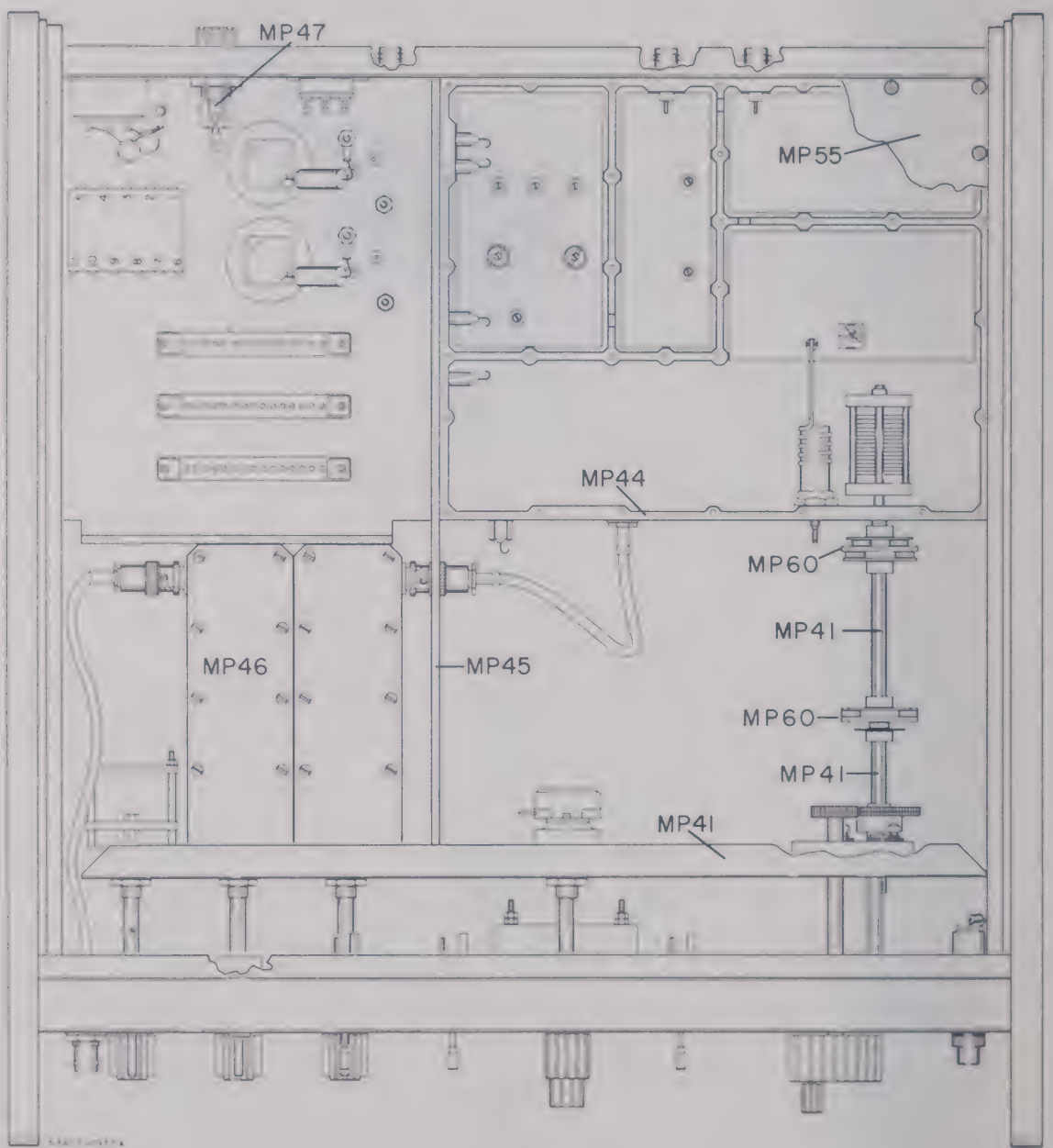


Figure 6-3. Mechanical Parts Location

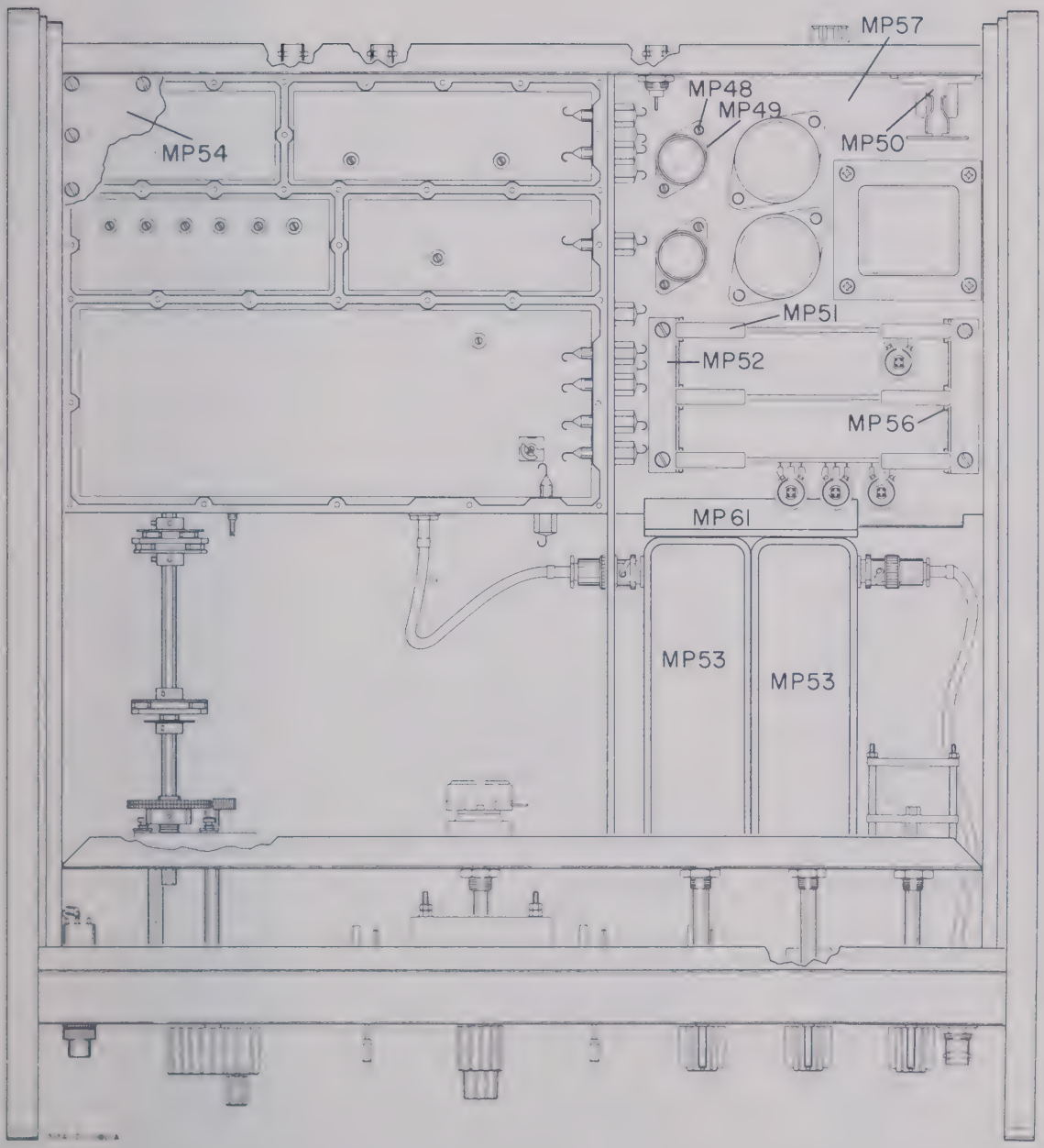


Figure 6-4. Mechanical Parts Location

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	PART NO		TQ	DESCRIPTION	MFR	MFR PART NO
A1				**POWER SUPPLY ASSEMBLY.**		
	00313-66501		1	PC Board Assembly	-hp-	
	1480-0116		2	Rollpin: steel plain	84396	59-032-156-1000
	5040-1464		2	Extractor	-hp-	
C1	0180-0149		4	C: fxd Al elect 65 μF +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
C2	0150-0093		41	C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C3	0180-0149			C: fxd Al elect 65 μF +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
C4	0180-0045		2	C: fxd Al elect 20 μF +75% -10% 25 vdcw	56289	30D206G025CB2-DSM
C5	0180-0149			C: fxd Al elect 65 μF +100% -10% 60 vdcw	56289	Type 30D D36987-DSM
C6	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C7	0180-0045			C: fxd Al elect 20 μF +75% -10% 25 vdcw	56289	30D206G025CB2-DSM
C8	0180-0149			C: fxd Al elect 65 μF +100% -10% 60 vdcw	56289	Type 30D D36978-DSM
CR1 thru CR4	1901-0026		4	Diode: Si 200 piv	24446	obd
CR5	1901-0025		1	Diode: Si 100 piv 12 pF 100 mA	04651	D3072
CR6	1902-0048		1	Diode: breakdown zener 6.81 V ±5% 400 mW	04713	SZ10939-134
Q1 thru Q4	1854-0215		8	TSTR: Si NPN 2N3904	04713	obd
R1	0686-5115		2	R: fxd comp 510Ω ±5% 1/2 W	01121	EB 5115
R2, R3	0683-5125		4	R: fxd comp 5100Ω ±5% 1/4 W	01121	CB 5125
R4	0683-5625		2	R: fxd comp 5600Ω ±5% 1/4 W	01121	CB 5625
R5	0698-3515		1	R: fxd met flm 5900Ω ±1% 1/8 W	19701	MF5C T-O obd
R6	0698-3497		1	R: fxd met flm 6040Ω ±1% 1/8 W	19701	MF5C T-O obd
R7*	0698-3442		1	R: fxd met flm 237Ω ±1% 1/8 W	75042	CEA T-O obd
R8, R9	0683-5125			R: fxd comp 5100Ω ±5% 1/4 W	01121	CB 5125
R10	0686-5115			R: fxd comp 510Ω ±5% 1/2 W	01121	EB 5115
R11	0683-5625			R: fxd comp 5600Ω ±5% 1/4 W	01121	CB 5625
R12	0683-3925		1	R: fxd comp 3900Ω ±5% 1/4 W	01121	CB 3925
R13	0757-0437		1	R: fxd met flm 4750Ω ±1% 1/8 W	19701	MF5C T-O obd
R14	0698-3226		1	R: fxd met flm 6490Ω ±1% 1/8 W	19701	MF5C T-O obd
R15	2100-0962		2	R: var comp lin 3000Ω ±30% 1/4 W	09569	MTC-1
A2				**DELTA OSCILLATOR ASSEMBLY.**		
	00313-66502		1	PC Board Assembly	-hp-	
	1480-0116		2	Rollpin: steel plain	84396	59-032-156-1000
	5040-1464		2	Extractor	-hp-	
C1	0180-0101		2	C: fxd Ta elect 1.8 μF ±10% 20 vdcw	56289	150D225X9020A2-DYS
C2	0180-1800		2	C: fxd Al elect 100 μF +100% -10% 6 vdcw	56289	30D603 DSM
C3	0180-0101			C: fxd Ta elect 1.8 μF ±10% 20 vdcw	56289	150D225X9020A2-DYS
C4	0180-1800			C: fxd Al elect 100 μF +100% -10% 6 vdcw	56289	30D603 DSM
C5	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C6	0180-0294		1	C: fxd Ta elect 390 μF ±20% 10 vdcw	56289	109D397X0010T2
DS1	2140-0248		1	Lamp: incandescent	24446	7344 obd
Q1	1853-0036		5	TSTR: Si PNP 2N3906	04713	2N3906-18
Q2	1854-0215		2	TSTR: Si PNP 2N3904	07263	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR	MFR PART NO
A2 (Cont'd)						
Q3	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-18
Q4	1854-0215			TSTR: Si PNP 2N3904	07263	obd
Q5	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-18
R1, R2	0683-2425		5	R: fxd comp 2400Ω ±5% 1/4 W	01121	CB 2425
R3	0698-3492		2	R: fxd met flm 2670Ω ±1% 1/8 W	75042	CEA T-O obd
R4	0683-1025		16	R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R5	0683-5115		9	R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R6, R7	0683-2425		5	R: fxd comp 2400Ω ±5% 1/4 W	01121	CB 2425
R8	0698-3492			R: fxd met flm 2670Ω ±1% 1/8 W	91637	obd
R9	0683-1025			R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R10	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R11*	0683-5615		2	R: fxd comp 560Ω ±5% 1/4 W	01121	CB 5615
R12	0686-1825		1	R: fxd comp 1800Ω ±5% 1/2 W	01121	EB 1825
R13, R14	0683-1035		7	R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
A3				**METER EXPAND AMPLIFIER AND AGC CONTROL AMPLIFIER ASSEMBLY.**		
	00313-66503		1	PC Board Assembly	-hp-	
C1, C2	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	56289	Type 30D D36978-DSM
C3	0180-0354		5	C: fxd Ta elect 40 μF ±5% 10 vdcw	56289	150D406X5010B2-DYS
	5040-1464		2	Extractor	-hp-	
	1480-0116		2	Rollpin: steel plain	84396	59-032-156-1000
C4	0140-0190		1	C: fxd mica 39 pF ±5%	04062	RDM15E390J3C
C5	0160-0302		1	C: fxd my 0.018 μF ±10% 200 vdcw	56289	192P18392-PTS
C6	0180-0376		1	C: fxd Ta elect 0.47 μF ±10% 35 vdcw	56289	150D474X9035A2-DYS
CR1	1902-0018		1	Diode: breakdown zener 11.7 V ±5%	04713	obd
Q1 thru Q4	1854-0033		10	TSTR: Si NPN 2N3391	24446	2N3391
Q5	1853-0036		2	TSTR: Si PNP 2N3906	04713	2N3906-18
Q6	1854-0033			TSTR: Si NPN 2N3391	24446	2N3391
Q7	1854-0215			TSTR: Si NPN 2N3904	04713	2N3904
Q8	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-18
Q9 thru Q13	1854-0033			TSTR: Si NPN 2N3391	24446	2N3391
R1*	0698-4020			R: fxd met flm 9.53 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R2	0757-0482			R: fxd met flm 511 kΩ ±1% 1/8 W	75042	CEA T-O obd
R3	0698-3557		1	R: fxd met flm 806Ω ±1% 1/8 W	75042	CEA T-O obd
R4	0757-0200		1	R: fxd met flm 5620Ω ±1% 1/8 W	19701	MF5C T-O obd
R5	0757-0465		2	R: fxd met flm 100 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R6	0757-0280		6	R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
R7	0757-0465			R: fxd met flm 100 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R8	0683-6825		2	R: fxd comp 6800Ω ±5% 1/4 W	01121	CB 6825
R9	0757-0280			R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
R10	0698-3260		1	R: fxd met flm 464 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R11	0698-3162		1	R: fxd met flm 46.4 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R12	0757-0288		2	R: fxd met flm 9090Ω ±1% 1/8 W	75042	CEA T-O obd
R13	0698-4429		1	R: fxd met flm 1870Ω ±1% 1/8 W	75042	CEA T-O obd
R14	2100-0909		2	R: var comp lin 100Ω ±30% 1/4 W	37942	MTC-1 obd
R15	0757-0420		3	R: fxd met flm 750Ω ±1% 1/8 W	75042	CEA T-O obd
R16	0757-0440		2	R: fxd met flm 7500Ω ±1% 1/8 W	19701	MF5C T-O obd
R17	0757-0441		1	R: fxd met flm 8250Ω ±1% 1/8 W	19701	MF5C T-O obd
R18	0757-0440			R: fxd met flm 7500Ω ±1% 1/8 W	19701	MF5C T-O obd
R19	0757-0482			R: fxd met flm 511 kΩ ±1% 1/8 W	75042	CEA T-O obd
R20	0757-0276		1	R: fxd met flm 61.9Ω ±1% 1/8 W	75042	CEA T-O obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	HP PART NO		TQ	DESCRIPTION	MFR	MFR PART NO
A3 (Cont'd)						
R21, R22	0757-0427		2	R: fxd met flm 1.5 kΩ ±1% 1/8 W	75042	CEA T-O obd
R23	2100-0909			R: var comp lin 100Ω ±30% 1/4 W	37942	MTC-1 obd
R24	0698-4421		1	R: fxd met flm 249Ω ±1% 1/8 W	75042	CEA T-O obd
R25	0698-3155		1	R: fxd met flm 4640Ω ±1% 1/8 W	75042	CEA T-O obd
R26*	0757-0288			R: fxd met flm 9090Ω ±1% 1/8 W	75042	CEA T-O obd
R27	0698-4055		1	R: fxd met flm 1000Ω ±1/4% 1/8 W	19701	MF5C T-O obd
R28	0757-0199		1	R: fxd met flm 21.5kΩ±1% 1/8 W	19701	MF5C T-O obd
R29	0757-0439		1	R: fxd met flm 6810Ω ±1% 1/8 W	19701	MF5C T-O obd
R30	0757-0280			R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
R31	2100-0908			R: var comp lin 2000Ω ±30% 1/4 W	37942	MTC-1 obd
R32, R33	0757-0465			R: fxd met flm 100 kΩ ±1% 1/8 W	19701	MF5C T-O obd
A4				**30MHz OSCILLATOR ASSEMBLY.**		
	00313-66504		1	PC Board Assembly	-hp-	
C1	0160-0763		1	C: fxd mica 5 pF ±10%	04062	RDM150C050K5S
C2, C3	0150-0093		2	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C4	0140-0196		3	C: fxd mica 150 pF ±5%	04062	RDM15F151J3C
C5	0140-0178		2	C: fxd mica 560 pF ±2%	04062	RDM15F751J3S
L1	9140-0047		1	Choke: R.F. 20 μH ±10%	99848	H51074020
L2	9100-1366		1	Coil: Inductor var 5-1/2 turns	-hp-	
Q1	1854-0057		1	TSTR: 2N3855	24446	obd
R1, R2	0683-2035		8	R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R3	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R4	0683-1525		1	R: fxd comp 1500Ω ±5% 1/4 W	01121	CB 1525
Y1	0410-0137		1	Crystal Quartz: 30 MHz ± 0.001% Third Overtone	91418	HP0030
A5				**AGC AMPLIFIER ASSEMBLY.**		
	00313-66505		1	PC Board Assembly	-hp-	
C1	0160-0938		2	C: fxd mica 1000 pF ±5%	00853	RDM15E102J1C
C2, C3	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C4	0140-0196			C: fxd mica 150 pF ±5%	04062	RDM15F151J3C
C5	0160-2035			C: fxd mica 750 pF ±5% 300 V	14655	RDM15F391J3C
C6	0150-0029		1	C: fxd TiO_2 1 pF ±10% 500 vdcw	78488	Type GA obd
C7	0160-0938			C: fxd mica 1000 pF ±5%	00853	RDM15E102J1C
C8, C9	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C10	0140-0196			C: fxd mica 150 pF ±5%	04062	RDM15F151J3C
C11	0160-2035		2	C: fxd mica 750 pF ±5% 300 V	04062	RDM15F751J3S
CR1, CR2	1901-0027		2	Diode: Si 1N4392 1 pF 10 wiv 0.5 ns	73293	obd
L1, L2	9100-1366			Coil: Inductor var 5-1/2 turns	-hp-	
Q1, Q2	1854-0219		12	TSTR: Si NPN 2N3663	24446	obd
R1, R2	0683-2035		4	R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R3	0683-3325		2	R: fxd comp 3300Ω ±5% 1/4 W	01121	CB 3325
R4	0757-0283		1	R: fxd met flm 2000Ω ±1% 1/8 W	75042	CEA T-O obd
R5	0757-0277			R: fxd met flm 49.9Ω ±1% 1/8 W	75042	CEA T-O obd
R6, R7	0683-2035		4	R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R8	0683-3325		2	R: fxd comp 3300Ω ±5% 1/4 W	01121	CB 3325
T1, T2	9100-1361		2	Transformer: Trifilar core	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATION	-hp- PART NO		TQ	DESCRIPTION	MFR	MFR PART NO
A6				**OUTPUT MIXER ASSEMBLY.**		
	00313-66506		1	PC Board Assembly	-hp-	
CR1 thru CR4	1910-0022		6	Diode: Ge 5 wiv 3.5 ns	93332	obd
R1	0698-4397		1	R: fxd met flm 84.5Ω ±1% 1/8 W	75042	CEA T-O obd
R2	0698-4415		1	R: fxd met flm 165Ω ±1% 1/8 W	75042	CEA T-O obd
R3 thru R6	0698-3444		4	R: fxd met flm 316Ω ±1% 1/8 W	75042	CEA T-O obd
T1, T2	9100-1361			Transformer: Trifilar core	-hp-	
A7				**LOW PASS FILTER ASSEMBLY.**		
	00313-66507		1	PC Board Assembly	-hp-	
C1	0160-2646		2	C: fxd mica 168.9 pF ±1%	04062	RDM15F(168.9)F3C
C2	0160-2647		2	C: fxd mica 302.4 pF ±1%	04062	RDM15F(302.4)F3C
C3	0160-2644		2	C: fxd mica 315.2 pF ±1%	04062	RDM15F(315.2)F3C
C4	0160-2645		1	C: fxd mica 317.3 pF ±1%	04062	RDM15F(317.3)F3C
C5	0160-2644			C: fxd mica 315.2 pF ±1%	04062	RDM15F(315.2)F3C
C6	0160-2647			C: fxd mica 302.4 pF ±1%	04062	RDM15F(302.4)F3C
C7	0160-2646			C: fxd mica 168.9 pF ±1%	04062	RDM15F(168.9)F3C
L1	9100-1363		2	Coil: Inductor preset 0.5096 μH	-hp-	
L2	9100-1364		2	Coil: Inductor preset 0.5740 μH	-hp-	
L3, L4	9100-1365		2	Coil: Inductor preset 0.5841 μH	-hp-	
L5	9100-1364			Coil: Inductor preset 0.5740 μH	-hp-	
L6	9100-1363			Coil: Inductor preset 0.5096 μH	-hp-	
A8				**POWER AMPLIFIER AND DETECTOR ASSEMBLY.**		
	00313-66508		1	PC Board Assembly	-hp-	
C1	0180-0155		11	C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C2	0140-0199		1	C: fxd mica 240 pF ±5%	04062	RDM15F241J3C
C3 thru C7	0180-0155			C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C8	0180-0116		7	C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C9	0150-0093		5	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C10	0160-0170		24	C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C11	0180-0155			C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C12 thru C16	0160-0170			C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C17	0180-0116			C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C18, C19	0150-0093			C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C20	0180-0116			C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C21	0160-0170			C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C22	0160-0127			C: fxd cer 1.0 μF ±20% 25 vdcw	56289	5C13C obd
C23	0180-0116			C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C24, C25	0150-0093			C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C26*	0140-0201		2	C: fxd mica 12 pF ±5%	72136	RDM15C120J5C
C27	0150-0115		2	C: fxd cer 27 pF ±10% 500 vdcw	72982	301-000-U2JO-270K
C28, C29	0180-0116			C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	HP PART NO		TQ	DESCRIPTION	MFR	MFR PART NO
A8 (Cont'd)						
C30	0160-0170			C: fxd cer 0.22 μF +80% -20% 25 vdcw	56289	5C9B obd
C31	0180-0116			C: fxd Ta elect 6.8 μF ±10% 35 vdcw	56289	150D685X9035B2-DYS
C32	0180-0155			C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C33	0121-0128		3	C: var air trimmer 1.4-7.3 pF on schematic	74970	189-505-5
C34	0180-0155			C: fxd Ta elect 2.2 μF ±20% 20 vdcw	56289	150D225X0020A2-DYS
C35, C36	0180-0354			C: fxd Ta elect 40 μF ±5% 10 vdcw	56289	150D406X5010B2-DYS
C37*, C38*	0140-0202			C: fxd mica 15 pF ±5%	04062	RDM15C150J5C
C39	0150-0093		6	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
CR1, CR2	1910-0036		4	Diode: Ge 10 mA/1V 8 piv 1 ns	73293	HPS1672
K1, K2	0490-0399		2	Relay Reed assembly: 12 Vdc 1200Ω	-hp-	
L1, L2	9140-0098		2	Coil: Inductor var 10-1/2 turns 2.2 μH	-hp-	
L3	9140-0047			Choke: RF 20 μH ±10% 2.5 MHz	99848	H51074020
Q1 thru Q3	1854-0219			TSTR: Si NPN 2N3663	24446	obd
Q4	1854-0254		4	TSTR: Si NPN 2N2218	04713	SS2184-2
Q5 thru Q7	1854-0233		4	TSTR: Si NPN 2N3866	07235	obd
Q8 thru Q12	1850-0062		10	TSTR: Ge 2N404	07235	34146 obd
Q13, Q14	1854-0092		4	TSTR: Si NPN 2N3563	04713	MPS 3563
R1	0757-0388		2	R: fxd met flm 30.1Ω ±1% 1/8 W	19701	MF5C T-O obd
R2	0698-3439		2	R: fxd met flm 178Ω ±1% 1/8 W	19701	MF5C T-O obd
R3	0757-0392		2	R: fxd met flm 43.2Ω ±1% 1/8 W	19701	MF5C T-O obd
R4	0683-1035		2	R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R5	0683-2025		2	R: fxd comp 2000Ω ±5% 1/4 W	01121	CB 2025
R6	0683-3015		5	R: fxd comp 300Ω ±5% 1/4 W	01121	CB 3015
R7	0683-3315		1	R: fxd comp 330Ω ±5% 1/4 W	01121	CB 3315
R8	0683-0685			R: fxd comp 6.8Ω ±5% 1/4 W	01121	CB 68G5
R9	0683-3015			R: fxd comp 300Ω ±5% 1/4 W	01121	CB 3015
R10	0683-5115		6	R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R11	0683-0685		3	R: fxd comp 6.8Ω ±5% 1/4 W	01121	CB 68G5
R12	0683-3015			R: fxd comp 300Ω ±5% 1/4 W	01121	CB 3015
R13	0683-0685			R: fxd comp 6.8Ω ±5% 1/4 W	01121	CB 68G5
R14	0683-3015			R: fxd comp 300Ω ±5% 1/4 W	01121	CB 3015
R15	0683-0825		2	R: fxd comp 8.2Ω ±5% 1/4 W	01121	CB 82G5
R16	0683-3015			R: fxd comp 300Ω ±5% 1/4 W	01121	CB 3015
R17	0683-0825			R: fxd comp 8.2Ω ±5% 1/4 W	01121	CB 82G5
R18	0698-3634		2	R: fxd met oxide 470Ω ±5% 2 W	07115	C42S obd
R19	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R20	0683-1015		2	R: fxd comp 100Ω ±5% 1/4 W	01121	CB 1015
R21	0683-1025		12	R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R22	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R23	0683-2725		2	R: fxd comp 2700Ω ±5% 1/4 W	01121	CB 2725
R24, R25	0683-1025			R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R26	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R27	0683-2725			R: fxd comp 2700Ω ±5% 1/4 W	01121	CB 2725
R28, R29	0683-1025			R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R30	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R31	0686-9115		2	R: fxd comp 910Ω ±5% 1/2 W	01121	EB 9115
R32, R33	0683-1025			R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R34	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO		TQ	DESCRIPTION	MFR	MFR PART NO
A8 (Cont'd)						
R35	0686-3315		4	R: fxd comp 330Ω ±5% 1/2 W	01121	EB 3315
R36, R37	0683-1025			R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R38	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R39	0686-3315			R: fxd comp 330Ω ±5% 1/2 W	01121	EB 3315
R40	0683-1025			R: fxd comp 1000Ω ±5% 1/4 W	01121	CB 1025
R41	0683-5105		2	R: fxd comp 51Ω ±5% 1/4 W	01121	CB 5105
R42	0683-6825			R: fxd comp 6800Ω ±5% 1/4 W	01121	CB 6825
R43	0683-3025		1	R: fxd comp 3000Ω ±5% 1/4 W	01121	CB 3025
R44	0698-5418		2	R: fxd met flm 50Ω ±1% 1/8 W	91637	MFF 1/8 T-O
R45	0698-6055		1	R: fxd met flm 108.11Ω ±1% 1/8 W	91637	MFF 1/8 T-2
R46	0698-6054		1	R: fxd met flm 73.124Ω ±1% 1/8 W	91637	MFF 1/8 T-2
R47, R48	0757-0413		4	R: fxd met flm 392Ω ±1% 1/8 W	75042	CEA T-O obd
R49*	0757-0411		1	R: fxd met flm 332Ω ±1% 1/8 W	19701	MF5C T-O obd
R50	0757-0417		2	R: fxd met flm 562Ω ±1% 1/8 W	75042	CEA T-O obd
R51	0757-0419		2	R: fxd met flm 681Ω ±1% 1/8 W	75042	CEA T-O obd
R52, R53	0757-0418		4	R: fxd met flm 619Ω ±1% 1/8 W	75042	CEA T-O obd
R54	0757-0416		4	R: fxd met flm 511Ω ±1% 1/8 W	75042	CEA T-O obd
R55	0757-0420		1	R: fxd met flm 750Ω ±1% 1/8 W	19701	MF5C T-O obd
R56	0757-0416			R: fxd prec met flm 511Ω ±1% 1/8 W	75042	CEA T-O obd
R57	0698-0084		2	R: fxd met flm 2150Ω ±1% 1/8 W	75042	CEA T-O obd
R58	2100-2216		2	R: var lin 5000Ω ±30% 1/2 W	73138	62PR obd
R59*	0757-0280			R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd
A9				**SINGLE SIDEBAND GENERATOR ASSEMBLY.**		
	00313-66509		1	PC Board Assembly	-hp-	
C1	0140-0197		1	C: fxd mica 180 pF ±5%	04062	RDM15F181J3C
C2, C3	0121-0037		2	C: var cer 5-25 pF on schematic	72982	538-002B2PO-93R
CR1 thru CR4	1901-0347		4	Diode: Si 20 mA at +1 1.5 pF	73293	5082-5350
L1	9100-1366			Coil: Inductor var 5-1/2 turns	-hp-	
R1, R2	0757-0407		2	R: fxd met flm 200Ω ±1% 1/8 W	75042	CEA T-O obd
R3 thru R6	0698-0022		4	R: fxd met flm 499Ω ±1% 1/8 W	75042	CEA T-2 obd
R7, R8	2100-2061		2	R: var flm 200Ω ±30% 1/2 W	73138	62PR200
R9	0757-0410		2	R: fxd met flm 301Ω ±1% 1/8 W	75042	CEA T-O obd
R10	2100-1984		1	R: var flm 100Ω ±30% 1/2 W	73138	62PR100
R11	0757-0410			R: fxd met flm 301Ω ±1% 1/8 W	75042	CEA T-O obd
R12, R13	0757-0280			R: fxd met flm 1000Ω ±1%	75042	CEA T-O obd
T1, T2	9100-1361		2	Transformer: Trifilar core	-hp-	
T3, T4	9100-1362		2	Transformer: Bifilar	-hp-	
A10				**BUFFER AMPLIFIER ASSEMBLY.**		
	00313-66510		1	PC Board Assembly	-hp-	
C1	0160-2035			C: fxd mica 750 pF ±5% 300 V	04062	RDM15F751J3S
C2	0150-0093		4	C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C3	0140-0217		2	C: fxd mica 140 pF ±2%	00853	RDM15F141G3C
C4	0140-0178		1	C: fxd mica 560 pF ±2%	04062	RDM15F561G3C
C5 thru C7	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C8	0140-0217			C: fxd mica 140 pF ±2%	04062	RDM15F141G3C
C9	0140-0200			C: fxd mica 390 pF ±5%	04062	RDM15F391J3C

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO		TQ	DESCRIPTION	MFR	MFR PART NO
L1, L2	9100-1366		2	Coil: Inductor var 5-1/2 turns	-hp-	
Q1	1854-0219			TSTR: Si NPN 2N3663	24446	obd
Q2	1854-0053			TSTR: Si NPN 2N2218	04713	obd
R1	0757-0277		1	R: fxd met flm 49.9Ω ±1% 1/8 W	19701	MF5C T-O obd
R2, R3	0683-2035		4	R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R4	0683-3325		1	R: fxd comp 3300Ω ±5% 1/4 W	01121	CB 3325
R5, R6	0683-2035			R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R7	0683-6215		1	R: fxd comp 620Ω ±5% 1/4 W	01121	CB 6215
A11				**BROABAND AMPLIFIER ASSEMBLY.**		
	00313-66511		1	PC Board Assembly	-hp-	
C1 thru C5	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C6	0140-0176		2	C: fxd mica 100 pF ±2%	04062	RDM15F101G3C
C7	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C8	0140-0176			C: fxd mica 100 pF ±2%	04062	RDM15F101G3C
C9, C10	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
K1, K2	0490-0399			Relay: Reed assembly 1200Ω	-hp-	
L1	9140-0106		1	Coil: fxd 0.47 μH ±20% 1340 mA	76493	9310-06
Q1 thru Q3	1854-0219			TSTR: Si NPN 2N3663	24446	obd
R1, R2	0757-0413			R: fxd met flm 392Ω ±1% 1/8 W	75042	CEA T-O obd
R3	0757-0277			R: fxd met flm 49.9Ω ±1% 1/8 W	19701	MF5C T-O obd
R4	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R5	0683-2035			R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R6	0683-2025			R: fxd comp 2000Ω ±5% 1/4 W	01121	CB 2025
R7	0683-5115			R: fxd comp 510Ω ±5% 1/4 W	01121	CB 5115
R8	0683-1035			R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035
R9	0683-2035			R: fxd comp 20 kΩ ±5% 1/4 W	01121	CB 2035
R10	0683-1325			R: fxd comp 1300Ω ±5% 1/4 W	01121	CB 1325
R11	0683-1015			R: fxd comp 100Ω ±5% 1/4 W	01121	CB 1015
R12	0683-1335		1	R: fxd comp 13 kΩ ±5% 1/4 W	01121	CB 1335
R13	0683-2425			R: fxd comp 2400Ω ±5% 1/4 W	01121	CB 2425
R14	0683-5615			R: fxd comp 560Ω ±5% 1/4 W	01121	CB 5615
R15	0683-5105			R: fxd comp 51Ω ±5% 1/4 W	01121	CB 5105
A12				**LOCAL OSCILLATOR ASSEMBLY.**		
	00313-66512		1	PC Board Assembly	-hp-	
	0340-0059		1	Terminal: standoff	00866	1332 obd
C1*	0140-0201			C: fxd mica 12 pF ±5%	72136	RDM15C120J5C
C2	0121-0128		1	C: var air 1.4 - 7.3 pF	74950	189-505-5
C3 thru C8	0150-0093			C: fxd cer 0.01 μF +80% -20% 100 vdcw	91418	TA obd
CR1, CR2	1910-0022			Diode: Ge 5 wiv 3.5 ns	93332	obd
Q1, Q2	1855-0046		2	TSTR: Si FET TIS 34	01295	T1S34
R1	0757-0461		1	R: fxd met flm 68.1 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R2	0757-0468		1	R: fxd met flm 130 kΩ ±1% 1/4 W	19701	MF5C T-O obd
R3	0757-0273		2	R: fxd met flm 3010Ω ±1% 1/8 W	19701	MF5C T-O obd
R4	0757-0410		1	R: fxd met flm 301Ω ±1% 1/8 W	75042	CEA T-O obd
R5	0757-0474		1	R: fxd met flm 243 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R6	0757-0481		1	R: fxd met flm 475 kΩ ±1% 1/8 W	19701	MF5C T-O obd
R7	0757-0273			R: fxd met flm 3010Ω ±1% 1/8 W	19701	MF5C T-O obd
R8	0757-0280			R: fxd met flm 1000Ω ±1% 1/8 W	75042	CEA T-O obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO		TQ	DESCRIPTION	MFR	MFR PART NO	
A13				**10dB STEP ATTENUATOR ASSEMBLY.**			
	00313-63401		1	Attenuator Assembly	-hp-		
J1	1250-0083			Connector: RF series BNC bulkhead mount jack	95712	30624-1	obd
R1, R2	0727-0091			R: fxd carbon flm 790Ω ±1/2% 1/4 W	19701	MF6C	obd
R3	0727-0028		4	R: fxd carbon flm 53.3Ω ±1/2% 1/4 W	19701	MF6C	obd
R4	0727-0016		1	R: fxd carbon flm 26.3Ω ±1/2% 1/2 W	19701	MF6C	obd
R5	0727-0028			R: fxd carbon flm 53.3Ω ±1/2% 1/4 W	19701	MF6C	obd
R6	0727-0037		1	R: fxd carbon flm 71.16Ω ± 1/2% 1/4 W	19701	MF6C	obd
R7, R8	0727-0042		2	R: fxd carbon flm 96.25Ω ± 1/2% 1/4 W	19701	MF6C	obd
R9	0727-0062		1	R: fxd carbon flm 247.5Ω ± 1/2% 1/4 W	19701	MF6C	obd
R10, R11	0727-0034		2	R: fxd carbon flm 61.11Ω ± 1/2% 1/4 W	19701	MF6C	obd
R12	0727-0091			R: fxd carbon flm 790Ω ± 1/2% 1/4 W	19701	MF6C	obd
R13, R14	0727-0028			R: fxd carbon flm 53.3Ω ± 1/2% 1/4 W	19701	MF6C	obd
S1 thru S8	3101-0933		16	Switch: sensitive subminiature	000LG	23SM13	
	355C-107D		1	Actuator switch: long	-hp-		
	355C-107E		3	Actuator switch: short	-hp-		
	355C-108A		1	Cam "A" attenuator	-hp-		
	355C-108B		1	Cam "B" attenuator	-hp-		
	355C-108C		1	Cam "C" attenuator	-hp-		
	355C-108D		1	Cam "D" attenuator	-hp-		
	355C-108E		1	Cam "E" attenuator	-hp-		
	739A-41A		1	Cover: accessory top	-hp-		
	739A-101		1	Pin: detent	-hp-		
	739A-102		1	Roller: assembly	-hp-		
	00313-23702		1	Shaft: straight	-hp-		
	739A-91		1	Spring: assembly	-hp-		
	00313-22001		1	Body	-hp-		
	0360-0124		1	Terminal: pin for printed circuit board	97300	obd	
	00313-21701		1	Bushing	-hp-		
A14				**1dB STEP ATTENUATOR ASSEMBLY.**			
	00313-63402		1	Attenuator Assembly	-hp-		
J1	1250-0083		2	Connector: RF series BNC jack	95712	30624-1	
R1, R2	0727-0010		3	R: fxd carbon flm 17.61Ω ± 1/2% 1/4 W	19701	MF6C	obd
R3	0727-0064		4	R: fxd carbon flm 292.4Ω ± 1/2% 1/4 W	19701	MF6C	obd
R4	0727-0379			R: fxd carbon flm 146.2Ω ± 1/2% 1/4 W	19701	MF6C	obd
R5	0727-0064			R: fxd carbon flm 292.4Ω ± 1/2% 1/4 W	19701	MF6C	obd
R6	0727-0005		1	R: fxd carbon flm 5.77Ω ± 1/2% 1/4 W	19701	MF6C	obd
R7, R8	0727-0094		2	R: fxd carbon flm 870Ω ± 1/2% 1/4 W	19701	MF6C	obd
R9	0727-0008		1	R: fxd carbon flm 11.61Ω ± 1/2% 1/4 W	19701	MF6C	obd
R10, R11	0727-0074			R: fxd carbon flm 463Ω ± 1/2% 1/4 W	19701	MF6C	obd
R12	0727-0010			R: fxd carbon flm 17.61Ω ± 1/2% 1/4 W	19701	MF6C	obd
R13, R14	0727-0064			R: fxd carbon flm 292.4Ω ± 1/2% 1/4 W	19701	MF6C	obd
R15	0757-1025		1	R: fxd met flm 25Ω ± 1% 1/4 W	19701	MF6C T-O	obd
S1 thru S8	3101-0933		8	Switch: sensitive subminiature SPDT	000LG	23SM13	obd
	355C-107D		1	Actuator: switch long	-hp-		
	355C-107E		3	Actuator: switch short	-hp-		
	00313-22002		1	Body: attenuator	-hp-		
	00313-21701		1	Bushing: front	-hp-		
	00313-61604		1	Cable assembly: output Opt. 01	-hp-		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO		TQ	DESCRIPTION	MFR	MFR PART NO	
A14 (Cont'd)							
	355C-108A		1	Cam "A" attenuator	-hp-		
	355C-108B		1	Cam "B" attenuator	-hp-		
	355C-108C		1	Cam "C" attenuator	-hp-		
	355C-108D		1	Cam "D" attenuator	-hp-		
	355C-108E		1	Cam "E" attenuator	-hp-		
	739A-41A			Cover: access, top	-hp-		
	739A-101		1	Pin: detent	-hp-		
	739A-102		1	Roller: assembly	-hp-		
	00313-23702		1	Shaft: straight	-hp-		
	739A-91		1	Spring assembly	-hp-		
	1200-0063		1	Receptacle: crimp type pin	00779	42428-3	
	1250-0083		1	Connector RF: series BNC jack	95712	30624-1	
A15				**0.1dB STEP ATTENUATOR ASSEMBLY.**			
	00313-61901		1	Attenuator Assembly	-hp-		
R1, R2	0698-4966		2	R: fxd met flm 340 kΩ ± 1% 1/2 W	75042	CEC T-O	obd
R3, R4	0757-0307		2	R: fxd met flm 322 kΩ ± 1% 1/2 W	75042	CEC T-O	obd
R5, R6	0698-4965		2	R: fxd met flm 324 kΩ ± 1% 1/2 W	75042	CEC T-O	obd
R7, R8	0698-3425		2	R: fxd met flm 316 kΩ ± 1% 1/2 W	75042	CEC T-O	obd
R9	0757-0312		1	R: fxd met flm 309 kΩ ± 1% 1/2 W	19701	MF7C T-O	obd
S1	3100-1746		1	Switch: rotary	71590	1332	obd
A16				**POWER AMPLIFIER AND DETECTOR ASSEMBLY. (OPTION 01)**			
	00313-66513		1	PC Board Assembly This board is identical to the A8 board except for:			
R49	0757-0282		1	R: fxd met flm 221Ω ± 1% 1/8 W	75042	CEA T-O	obd
A17				**1dB STEP ATTENUATOR ASSEMBLY. (OPTION 01)**			
	00313-63403		1	Attenuator Assembly (Option 01) This attenuator is identical to the A14 attenuator except as follows: A14R15 replaced by a shorting strip A14J1 deleted (output cable W3 attaches directly to A17 Attenuator Assembly)	-hp-		
				MECHANICAL PARTS.			
A1	00313-66501		1	Board: power supply	-hp-		
A2	00313-66502		1	Board: oscillator	-hp-		
A3	00313-66503		1	Board: amplifier	-hp-		
A4	00313-66504		1	Board: XTAL oscillator	-hp-		
A5	00313-66505		1	Board: AGC amplifier	-hp-		
A6	00313-66506		1	Board: output mixer	-hp-		
A7	00313-66507		1	Board: L. P. filter	-hp-		
A8	00313-66508		1	Board: RF amplifier and detector (standard only)	-hp-		
A9	00313-66509		1	Board: SSB generator	-hp-		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR	MFR PART NO
				MECHANICAL PARTS (Cont'd)		
A10	00313-66510		1	Board: 30 MHz buffer	-hp-	
A11	00313-66511		1	Board: bandpass amplifier	-hp-	
A12	00313-66512		1	Board: local oscillator	-hp-	
A13	00313-63401		1	Attenuator assembly: 10 dB step	-hp-	
A14	00313-63402		1	Attenuator assembly: 1 dB step	-hp-	
A15	00313-61901		1	Switch: attenuator assembly	-hp-	
A16 (A8 Opt. 01)	00313-66513		1	Board: RF amplifier and detector (Opt. 01 only) This board is identical to 00313-66508 board except for value of A16R49 A16R49 is 221Ω	-hp-	
A17	00313-63403		1	Switch: attenuator assembly 1 dB step (Opt. 01 only)	-hp-	
C1, C2	0180-0047		2	C: fxd 500 μF 75 vdcw	56289	D32443
C3, C4	0150-0023		2	C: fxd cer 2000 pF ±20% 1000 vdcw	56289	19C203A
C5	0121-0194		1	C: var air 4.8 to 100 pF	74970	148-6-HB
C6 thru C9	0150-0093		4	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
C10 thru C21	0150-0019		12	C: fxd 0.001 feedthru cer 1000 pF ± 20%	72982	327005X5U0 102M
F1	2110-0044		1	Fuse: 0.30 A slow-blow (115 V)	75915	313.300
	2110-0017			Fuse: 0.15 A slow-blow	75915	313.150
J1	1251-0148		1	Connector: AC power 3 pin recessed power cord receptacle	82389	AC3G
J2	1251-0095		1	Connector: power AC chassis mounting socket	75382	221 obd
J3, J4	1250-0118		2	Connector: RF series BNC bulkhead mount jack receptacle	74868	82-2908-2
J5, J6	1250-0083		2	Connector: RF bulkhead mount jack	95712	30624-1 obd
J7	00313-61603			Part of cable W3	-hp-	
J8 thru J10	1251-0135		3	Connector: printed circuit	74868	143-015-08 (1158)
L1	9100-1368		1	Coil: var (uses form 9150-0376)	-hp-	
L2, L3	9140-0018		2	Coil: RF choke 1 μH	99849	205-11-10
M1	1120-0930		1	Meter	55026	1332 obd
MP1	5000-0737		2	Cover: side front	-hp-	
MP2	5000-0736		2	Cover: side rear	-hp-	
MP3	5060-0740		1	Cover: top	-hp-	
MP4	00313-00202		1	Panel: rear	-hp-	
MP5	5000-0051		2	Plate: fluted aluminum	-hp-	
MP6	00313-24401		2	Frame: assembly	-hp-	
MP7	5060-0766		2	Retainer: 4H handle	-hp-	
MP8	5060-0763		2	Handle: assembly	-hp-	
MP9	5060-0752		1	Cover: bottom	-hp-	
MP10	5060-0767		5	Foot: assembly	-hp-	
MP11	1490-0030		1	Stand: tilt	91260	obd
MP12	00313-00201		1	Panel: front	-hp-	
MP12 Opt. 01	00313-00203		1	Panel: front	-hp-	
MP13	5000-5835		2	Strip: trim	-hp-	
MP14	00313-04301		1	Panel: plate	-hp-	
MP15	5000-5836		1	Strip: top front panel	-hp-	
MP16				Not assigned		
MP17	00313-24702		1	Support: tuner drive bearing	-hp-	
MP18	5060-0021		1	Gear Assembly	-hp-	
MP19	5060-0020		1	Gear Assembly	-hp-	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO		TQ	DESCRIPTION	MFR	MFR PART NO	
				MECHANICAL PARTS (Cont'd)			
MP20	00313-23601		1	Gear: drive assembly	-hp-		
MP21	00313-24701		1	Spacer: (Stand off)	-hp-		
MP22	1500-0783		1	Drive Mechanism	000LC	45"/DAF SPEC	
MP23				Not assigned			
MP24	00313-04001		1	Dial: frequency	-hp-		
MP25	1410-0103		1	Bushing: oscillator tuning	13603	FAD 250	
MP26	00313-49901		1	Inductor: frequency dial (bezel)	-hp-		
MP27	0370-0146		1	Knob: oscillator tuning assembly	-hp-		
MP28	0370-0128		1	Knob: 3/4" scale offset round black	-hp-		
MP29	0370-0114		1	Knob: round 5/8" diam red (scale offset)	-hp-		
MP30	0370-0432		3	Knob: lever black	-hp-		
MP31	5040-0685		1	Meter: window bezel	-hp-		
MP32	1410-0112		1	Bushing: brass	14480	obd	
MP33	0370-0330		3	Knob: 4 fluted 5/8" bar type (black)	-hp-		
MP34	5040-0687		1	Bezel: rear window	-hp-		
MP35	5040-0686		2	Bezel: front window	-hp-		
MP36	5020-0446		1	Standoff: hex	-hp-		
MP37	1460-0256		4	Spring: meter compression	91260	obd	
MP38	1410-0872		1	Bushing: threaded	14480	obd	
MP39	5040-0690		3	Dial: attenuator molded	-hp-		
	7120-0870		3	Decal	91345	1332	obd
MP40	00313-04901		1	Gusset: front	-hp-		
MP41	5020-0350		2	Shaft: 5-1/8"	-hp-		
MP42	1500-0001		2	Coupler: flexible	80583	FNC-46-S	
MP43				Not assigned			
MP44	5000-1052		1	Casting: RF	-hp-		
MP45	00313-04902		1	Gusset: center	-hp-		
MP46	00313-04103		2	Cover: attenuator bottom	-hp-		
MP47	1400-0084		1	Holder: fuse extractor post type	75915	342014	
MP48	1200-0043		2	Insulator: transistor mtg anodized Al plate	000LB	293011	
MP49	1200-0081		4	Insulator: bushing	26365	974 Special	
MP50	1251-0156		1	Connector: nylon receptacle	83982	CS 402ACG	
MP51	5040-1464		6	Extractor: board	-hp-		
MP52	00313-01201		2	Bracket: circuit guide	-hp-		
MP53	739A-41A		2	Cover: attenuator top	-hp-		
MP54	00313-04101		1	Cover: top casting	-hp-		
MP55	00313-04102		1	Cover: bottom casting	-hp-		
MP56	5040-0601		6	Guide: printed circuit	-hp-		
MP57	00313-00101		1	Deck	-hp-		
MP58	1410-0052		1	Bushing: potentiometer	71785	CSM	obd
MP59	7120-1254		1	Nameplate	000LH	obd	
MP60	1500-0001		2	Coupler: flexible for 1/4" diameter shafts	80583	FNC-46-S	
MP61	00313-01202		1	Bracket: attenuator mounting	-hp-		
Q1, Q2	1854-0063		2	TSTR: Si NPN 2N3055	04713	2N3055	
R1, R2	0692-1005		2	R: fxd comp 10Ω ± 5% 2 W	01121	HB 1005	
R3	0684-3331		1	R: fxd comp 33 kΩ ± 10% 1/4 W	01121	CB 3331	
R4	0698-4482		1	R: fxd met flm 17.4 kΩ ± 1% 1/8 W	75042	CEA T-O	obd
R5	0698-0083		1	R: fxd met flm 1960Ω ± 1% 1/8 W	75042	CEA T-O	obd
R6	2100-0078		1	R: var comp lin 500Ω ± 30% 3/10 W	71450	Series 70	obd
R7	2100-2295		1	R: var comp panel 2.5 kΩ ± 10% - rear 100Ω ± 20%	01121	Type JJC	obd
S1	3101-0100		1	Switch: pushbutton lighted with transparent red lens	87034	54-61681-26 A1H	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
				MECHANICAL PARTS (Cont'd)			
S2	3101-0033		1	Switch: 115/230 V	71590	1332	obd
S3	3101-0820		1	Switch: lever oscillator mode	71590	1332	obd
S4	3101-0819		1	Switch: meter mode	71590	1332	obd
S5	3101-0820		1	Switch: lever oscillator mode	71590	1332	obd
T1	9100-1345		1	Transformer: power	-hp-		
W1	8120-0078			Assembly: cable 7.5 ft power cord set	70903	KH-4147	
W2	00313-61602		1	Cable: output casting assembly	-hp-		
W3	00313-61603		1	Cable: output connector assembly standard only	-hp-		
W3 (Opt. 01)	00313-61604			Cable assembly: output (Opt. 01 only)	-hp-		
W4	00313-61601		1	Cable: main	-hp-		
				MISCELLANEOUS			
	11086A		3	Accessory: (cables) coaxial 24"	-hp-		
	1250-0701		2	Bushing: RF connector for series BNC TNC connectors	95712	9520-3	obd
	9211-0249		1	Carton: corrugated	09051	obd	
	5060-4940		1	Extender assembly: 15 pin	-hp-		
	9223-0040		4	Foam: polyethylene post pak	04811	obd	
	1250-0299		2	Insulator: RF connector back-insulator for series BNC/TNC connectors	95712	2624-1	
	5060-0775		1	Kit: 5 H rack mount	-hp-		
	5020-0708		1	bracket	-hp-		
	5020-0709		1	bracket	-hp-		
	11086-61601		3	cable	-hp-		
	5060-4940		1	extender board	-hp-		
	5040-0164		1	filler strip	-hp-		
	5950-4401		1	label	-hp-		
	2550-0018		4	machine screw	-hp-		
	9220-0195		1	polyboard	-hp-		
	8120-0078		1	power cord	-hp-		
	00313-90001		1	Manual	-hp-		
	2950-0054		1	Nut: hex brass nickel plated	95712	obd	
			2	Nut: RF connector clamp for series BNC/TNC connectors	95712	834-33	obd
	7122-0082		1	Plate: serial	04716	obd	
	00313-23701		1	Shaft: 1-5/8" (5020-0341)	-hp-		
	0362-0027		2	Sleeve: cable terminal bronze	59730	GSC-2195	
			2	Washer: flat for series BNC RF connectors	95712	2053-8	
	2370-0013		8	Screws, top and bottom attaching	73076	obd	
	2370-0020		8	Screws, side cover attaching	83385	obd	

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section of the manual contains circuit diagrams for the Model 313A. Included is a block diagram, a functional diagram, an interconnecting block diagram between the Model 313A and the Model 312A and schematic diagrams.

7-3. BLOCK DIAGRAM.

7-4. The block diagram (Figure 7-1) shows how the circuits in the Model 313A are functionally arranged to form a Tracking Oscillator.

7-5. FUNCTIONAL DIAGRAM.

7-6. The functional diagram (Figure 7-3) is similar to the block diagram except more detailed information is included. Included in the functional diagram are adjustments, waveforms, frequencies, switches and relays as related to the functional operation of the Model 313A.

7-7. Circuits located within the RF casting are shown enclosed by dashed lines. Individual compartments within the casting are also shown enclosed with dashed lines. Feedthru capacitors which supply operating potentials to circuits within the casting are shown. Connections between circuit boards within the casting are made by pin type connectors.

7-8. Numbers enclosed in circles relate to the troubleshooting tree (Figure 5-10) and indicate the sequence in which troubleshooting steps should be performed.

7-9. SCHEMATIC DIAGRAMS.

7-10. The schematic diagrams (Figures 7-4 through 7-9) contained in this section show the detailed circuits in the Model 313A. Individual circuit boards are shown enclosed in dashed lines. Some components which are part of a particular circuit but physically located off the board are shown on the board and are enclosed by a series of short diagonal lines.

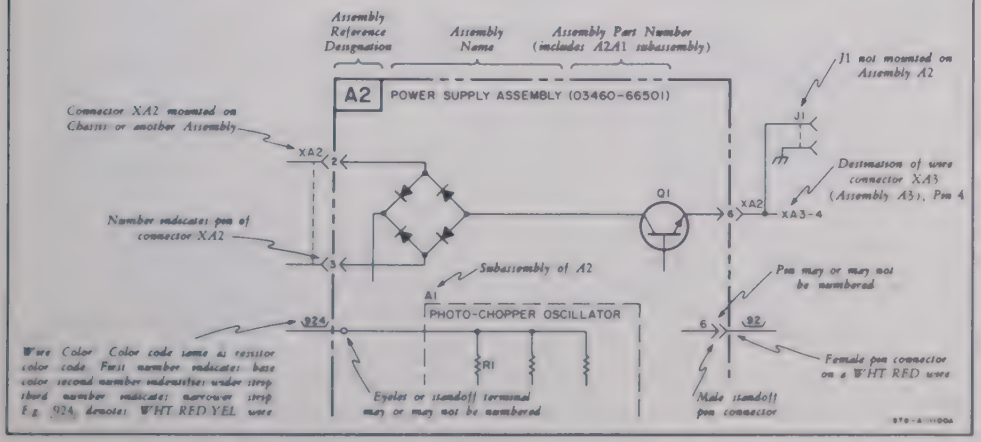
7-11. Components marked with an asterisk are those that are critical in value. The value of these components may vary from one instrument to another due to variations in transistor Beta etc. and the values shown on the schematic are average. Numbers in parenthesis indicate the paragraph number in the manual where the method of selecting the optimum value can be found.

7-12. Voltage levels and some waveforms have been included on the schematics. When measuring these voltages a high input impedance voltmeter (10 megohms or greater) and oscilloscope should be used to prevent circuit loading.

REFERENCE DESIGNATIONS

PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1



GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.

   RESISTANCE IN OHMS

   CAPACITANCE IN MICROFARADS

   INDUCTANCE IN MICROHENRIES

3. DENOTES ASSEMBLY GROUND.
   DENOTES CHASSIS GROUND WITHIN RF CASTING.

4. DENOTES CHASSIS GROUND.

5. DENOTES ASSEMBLY.

6. DENOTES RF CASTING.

7. DENOTES MAIN SIGNAL PATH.

8. DENOTES FEEDBACK PATH.

9. DENOTES FRONT PANEL MARKING.

10. DENOTES REAR PANEL MARKING.

11. DENOTES SCREWDRIVER ADJUST.

12. DENOTES FRONT PANEL CONTROL.

13. \924/ DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP.
    (e. g. \924/ = WHITE, RED, YELLOW.)

14. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.

15. (0-00) NUMBERS IN PARENTHESIS INDICATE THE PARAGRAPH NUMBER IN MANUAL WHERE METHOD OF SELECTING STARRED VALUES IS FOUND.

16. TRANSISTORS ARE ALL CONNECTED TO CIRCUIT BOARD IN TO-5 CONFIGURATION, ie, AS VIEWED FROM THE COMPONENT SIDE OF BOARD.

17. WAVEFORM AND VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING A HIGH INPUT IMPEDANCE OSCILLOSCOPE AND TRANSISTOR VOLTMETER. VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY SOMEWHAT FROM ONE INSTRUMENT TO ANOTHER.

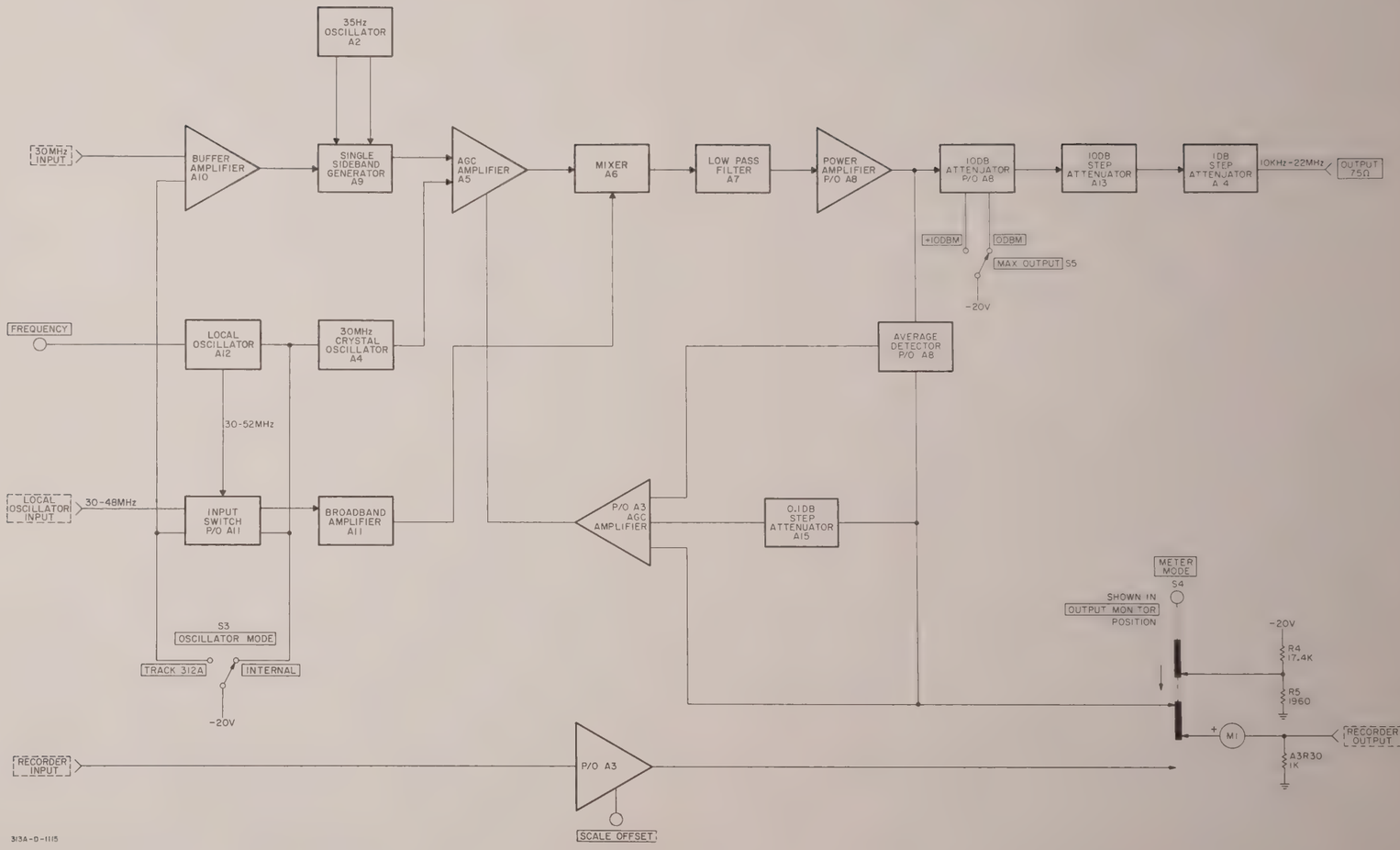


Figure 7-1. 313A Block Diagram

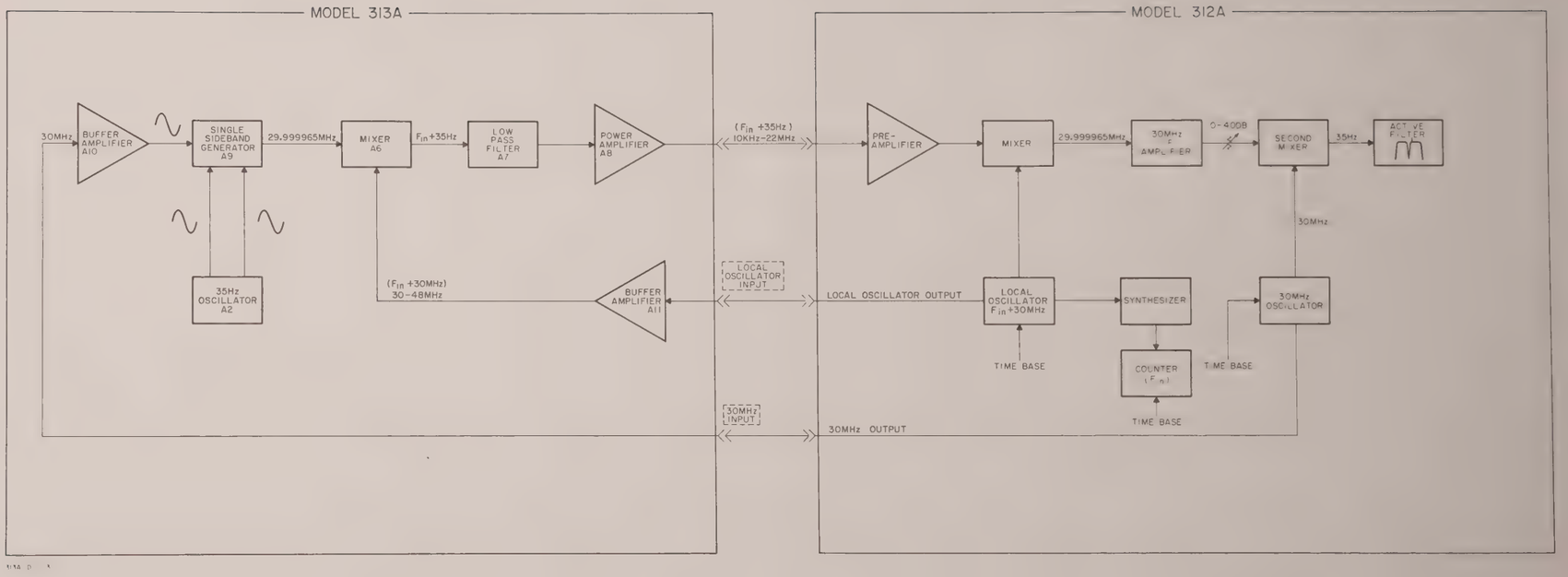


Figure 7-2. 313A-312A Interconnecting Block Diagram

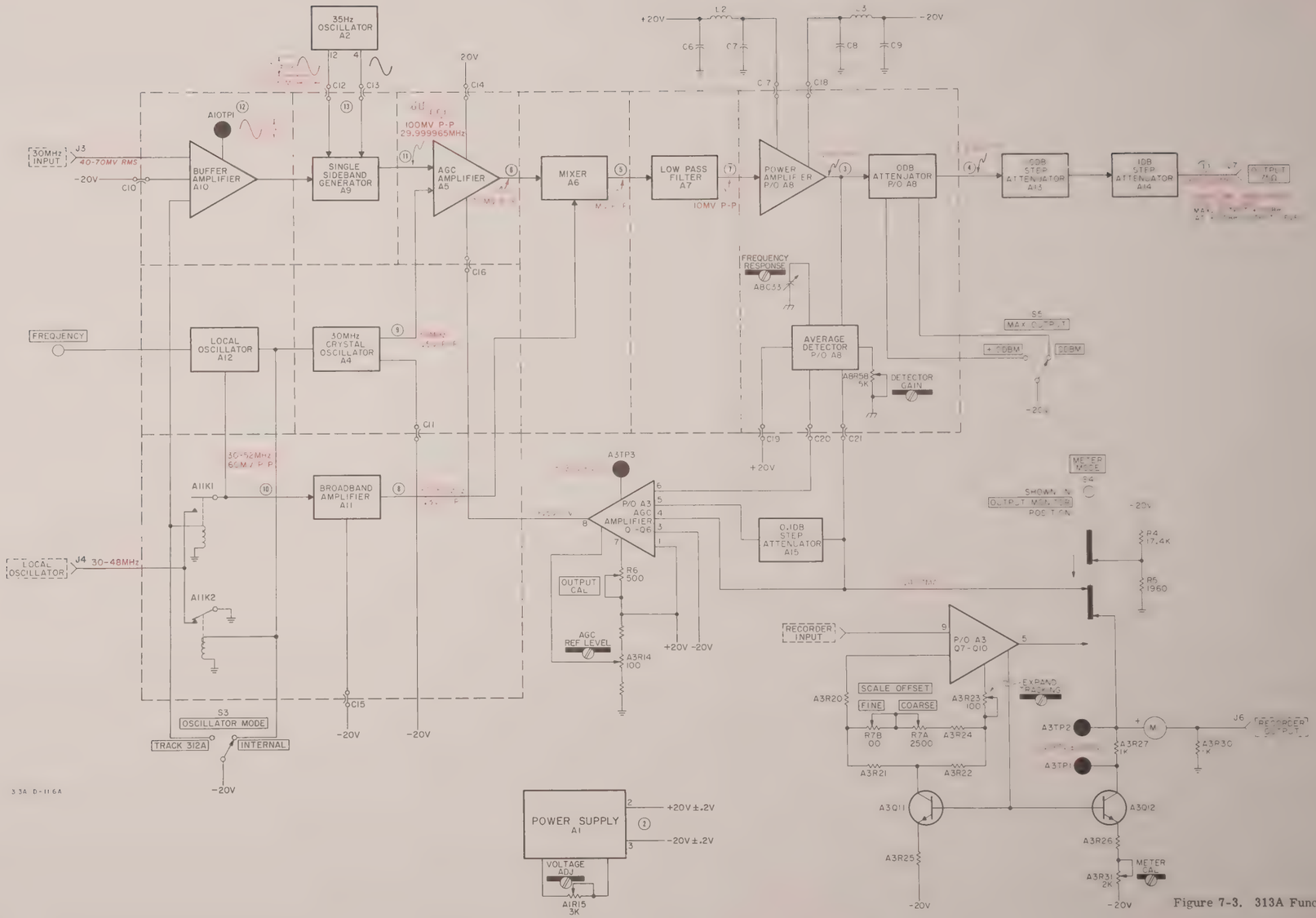
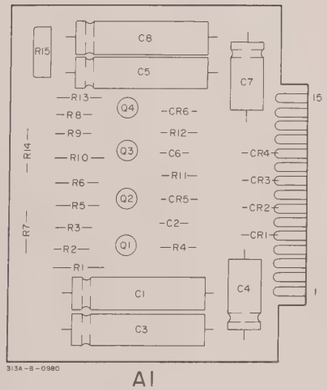


Figure 7-3. 313A Functional Diagram



A1

hp Part No. (00313-66501)

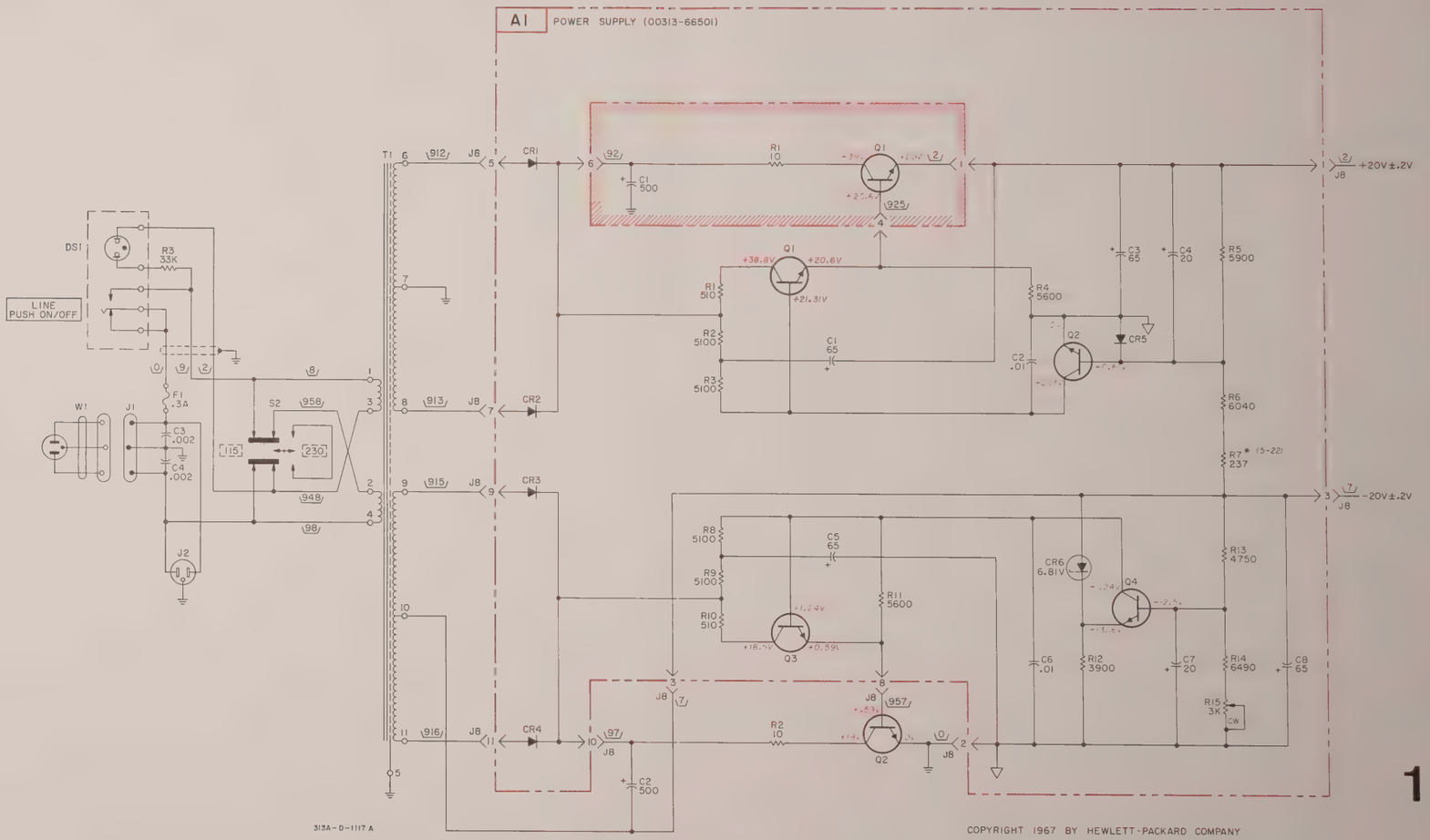
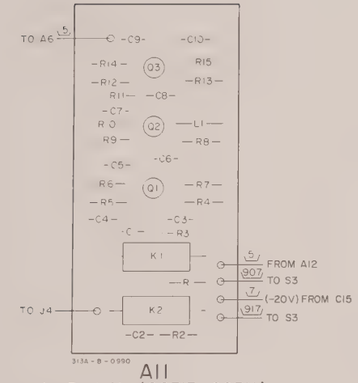
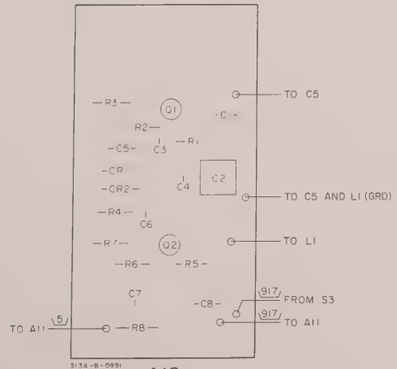


Figure 7-4. Power Supply (A1) Schematic and Component Location Diagram



A11
hp Part No.(00313-66511)



A12
hp Part No.(00313-66512)

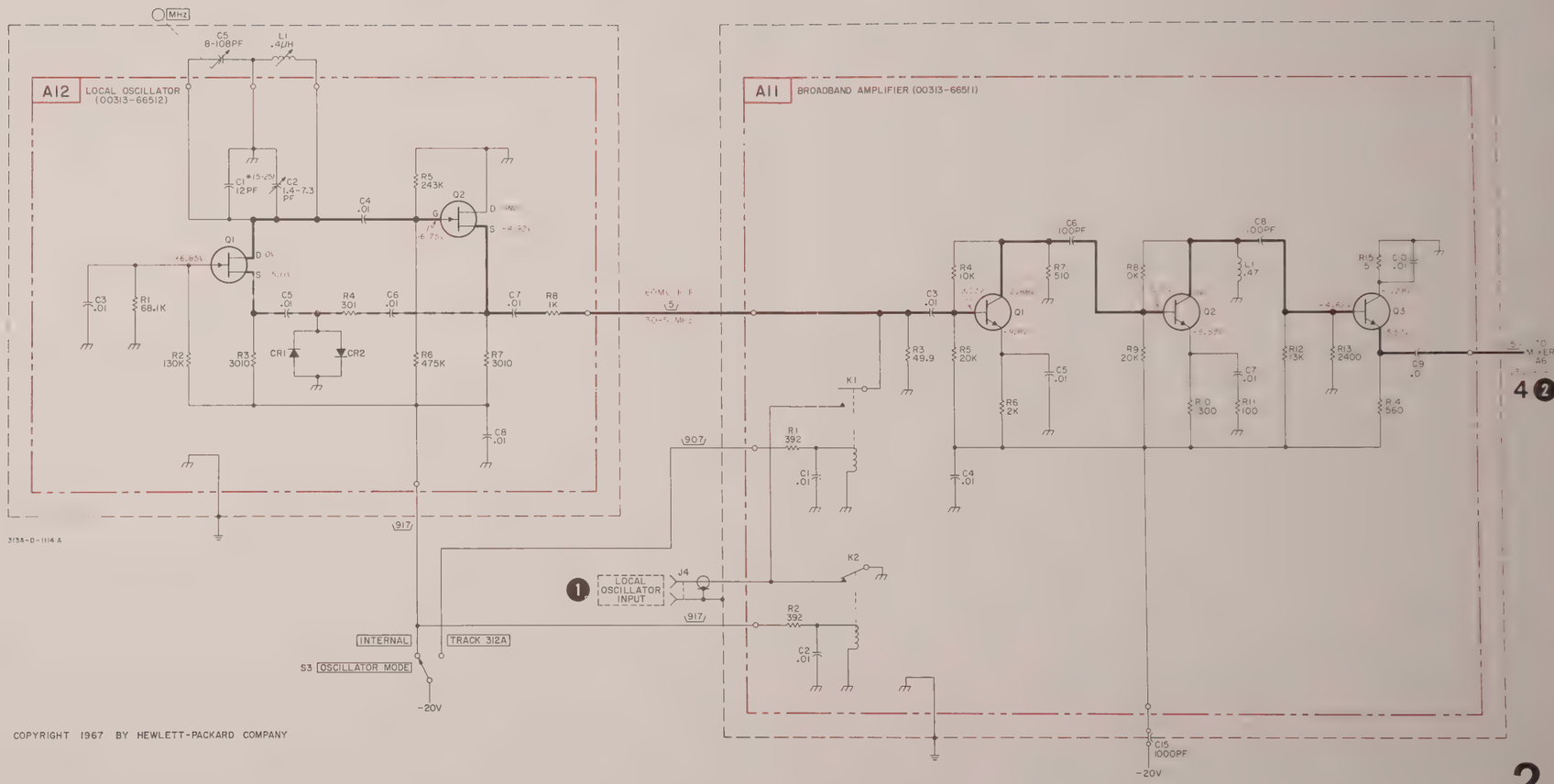


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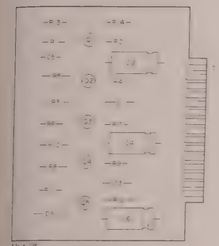
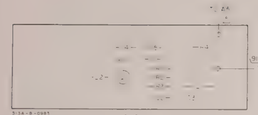
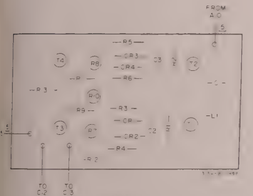
Figure 7-5. Local Oscillator (A12) Buffer Amplifier (A11) Schematic and Component Location Diagrams



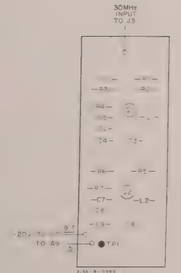
A2
hp Part No. (00313-66502)



A4
hp Part No. (00313-66504)



A9
hp Part No. (00313-66509)



A10
hp Part No. (00313-66510)

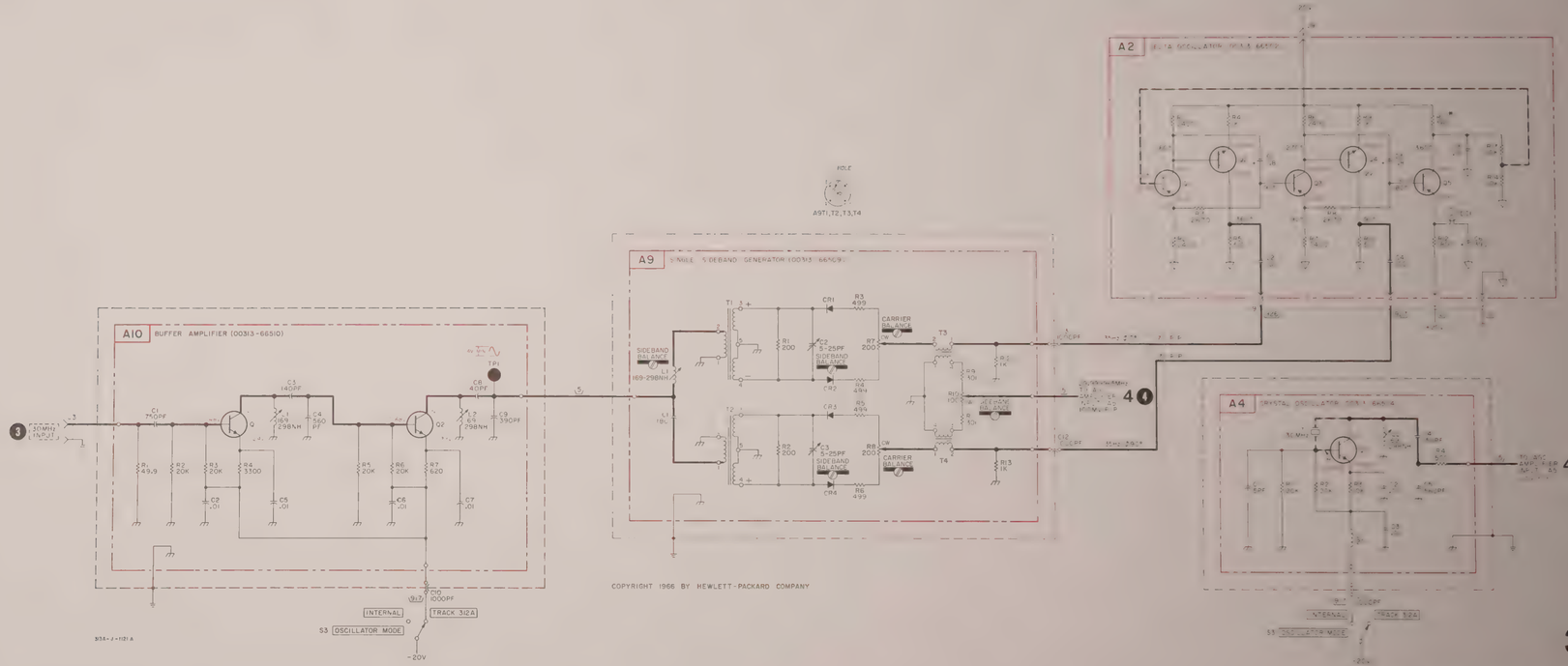
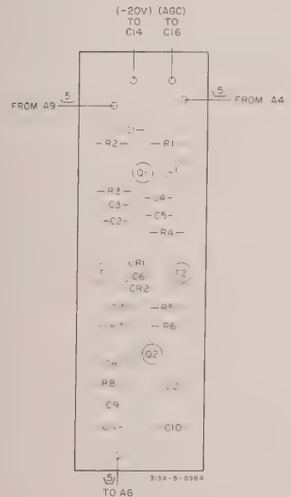
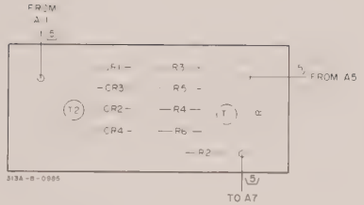


Figure 7-6. Buffer Amplifier (A10), Single Sideband Generator (A9), Delta Oscillator (A2) Crystal Oscillator (A4) Schematic and Component Location Diagram

01818-1



A5
hp Part No. (00313-66505)



A6
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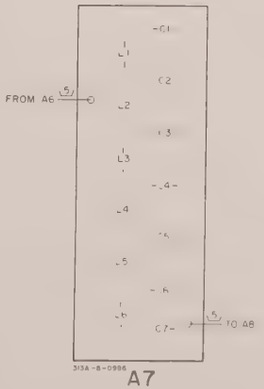

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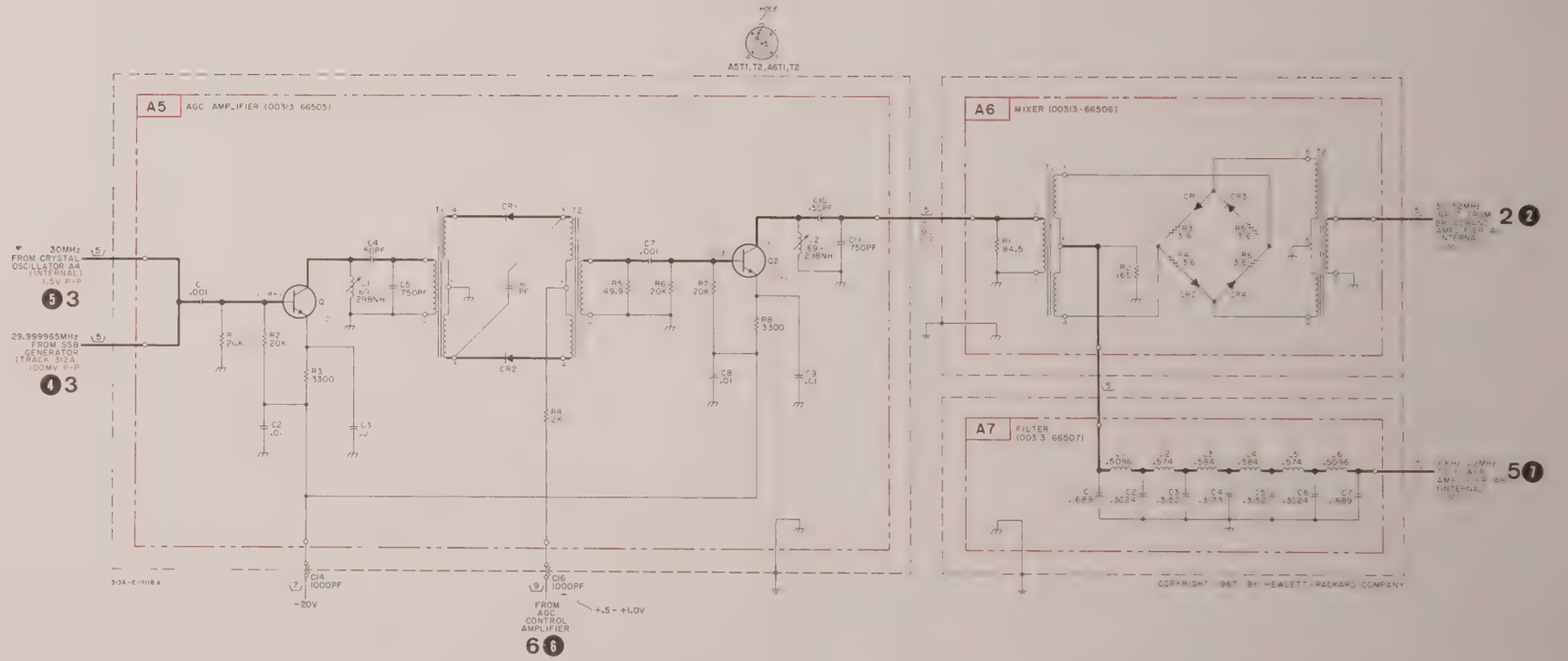
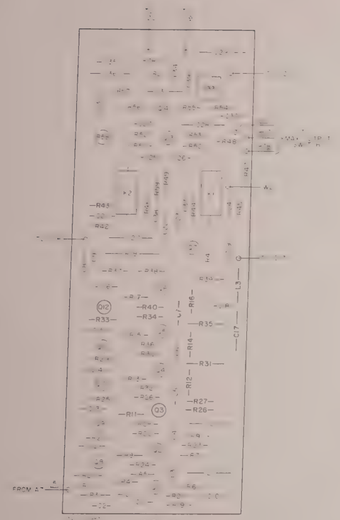


4

Figure 7-7. AGC Amplifier (A5), Mixer (A6) Low Pass Filter (A7) Schematic and Component Location Diagrams



A8
hp Part No. (00313-66508)

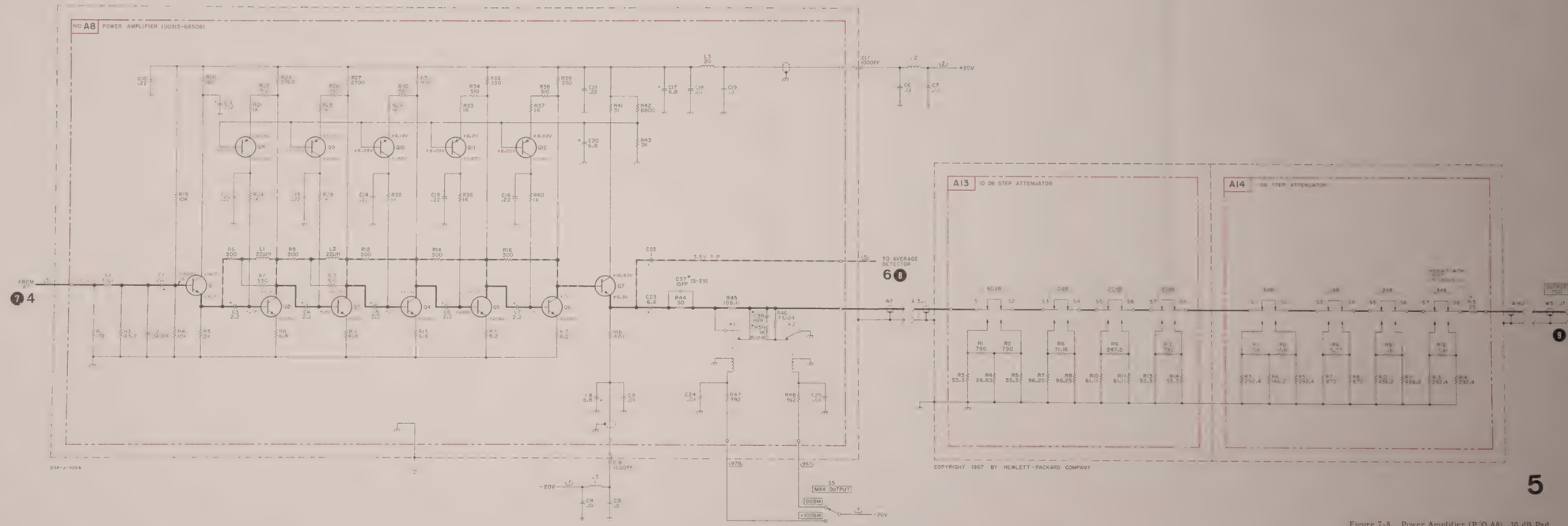
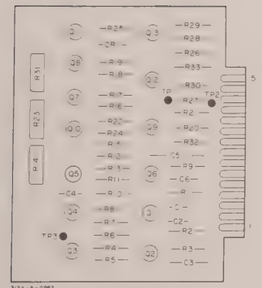


Figure 7-8. Power Amplifier (P/O A8), 10 dB Pad (P/O A8), 10 dB Step Attenuator (A13), 1 dB Step Attenuator (A14) Schematic and Component Location Diagrams.



A3
hp Part No. (00313-66503)

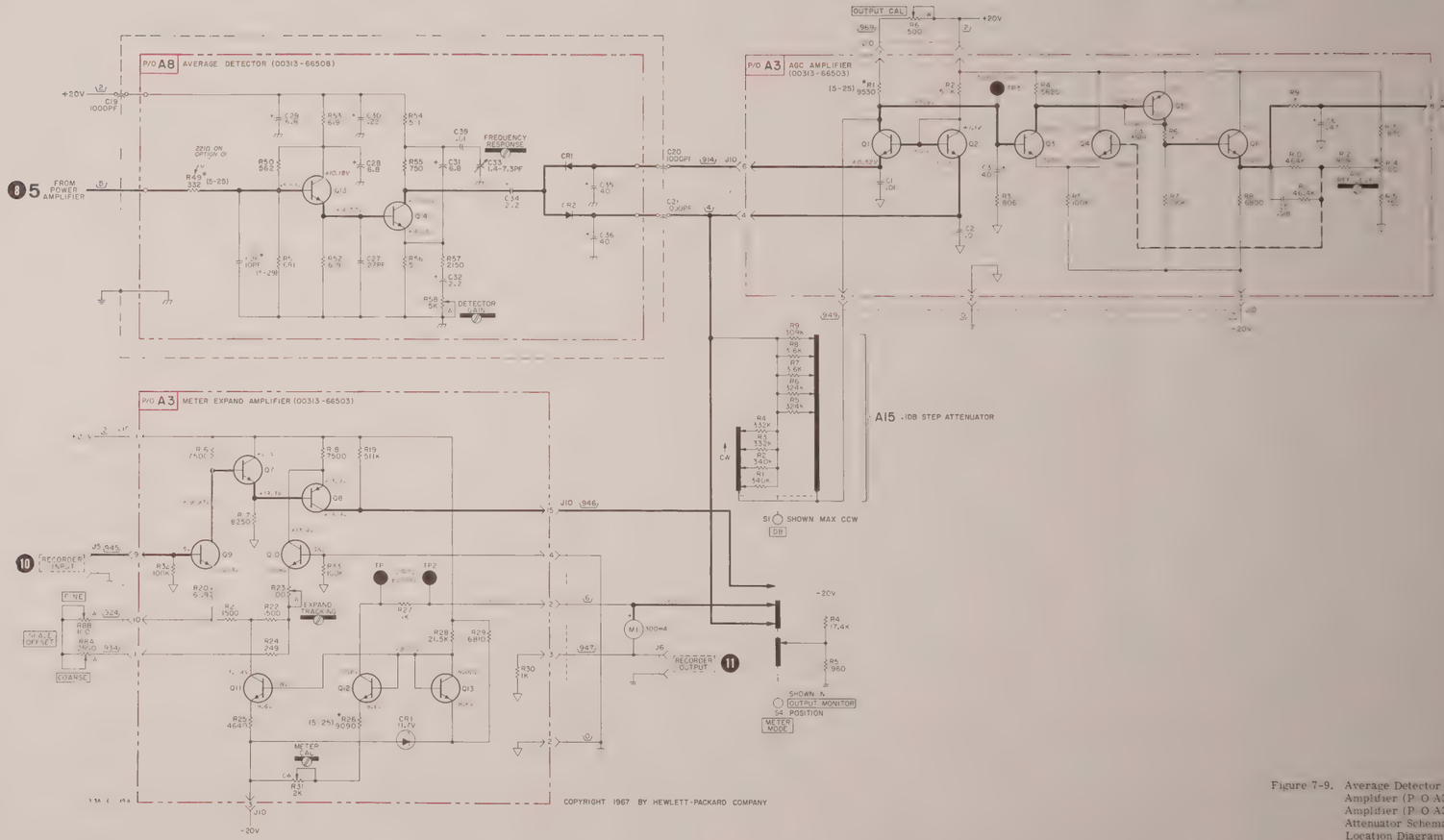


Figure 7-9. Average Detector (P/O A8), AGC Amplifier (P/O A3), Meter Expand Amplifier (P/O A3), 0.1 dB Step Attenuator Schematic and Component Location Diagrams

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
[illegible]	U.S.A. Common	Any supplier of U.S.
[illegible]	McCoy Electronics	Mount Holly Springs, Pa.
[illegible]	Stage Electronics Corp	Rochester, N.Y.
[illegible]	Cann, Inc	Danielson, Conn.
[illegible]	Hughes	Colton, Calif.
[illegible]	Micristion Co., Inc.	Valley Stream, N.Y.
[illegible]	Garlock Inc	Cherry Hill, N.J.
[illegible]	Aerovox Corp	New Bedford, Mass.
[illegible]	Amp Inc.	Harrisburg, Pa.
[illegible]	Aircraft Radio Corp.	Boonton, N.J.
[illegible]	Northern Engineering Laboratories, Inc.	Burlington, Wis.
[illegible]	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
[illegible]	Coe Engineering Co.	City of Industry, Cal.
[illegible]	Carl E. Holmes Corp.	Los Angeles, Calif.
[illegible]	Microlab Inc.	Livingston, N.J.
[illegible]	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
[illegible]	Alden Products Co.	Brockton, Mass.
[illegible]	Allen Bradley Co.	Milwaukee, Wis.
[illegible]	Litton Industries, Inc.	Beverly Hills, Calif.
[illegible]	TRW Semiconductors, Inc.	Lawndale, Calif.
[illegible]	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
[illegible]	The Alliance Mfg. Co.	Alliance, Ohio
[illegible]	Pacific Relays, Inc.	Van Nuys, Calif.
[illegible]	Amerock Corp.	Rockford, Ill.
[illegible]	Pulse Engineering Co.	Santa Clara, Calif.
[illegible]	Ferroxcube Corp. of America	Saugerties, N.Y.
[illegible]	Wheelock Signals, Inc.	Long Branch, N.J.
[illegible]	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
[illegible]	Amphenol-Borg Electronics Corp.	Chicago, Ill.
[illegible]	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
[illegible]	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
[illegible]	Hopkins Engineering Co.	San Fernando, Calif.
[illegible]	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
[illegible]	Apex Machine & Tool Co.	Dayton, Ohio
[illegible]	Eldema Corp.	Compton, Calif
[illegible]	Transitron Electric Corp.	Wakefield, Mass.
[illegible]	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
[illegible]	Singer Co., Diehl Div. Finderne Plant	Somerville, N.J.
[illegible]	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
[illegible]	Taurus Corp.	Lambertville, N.J.
[illegible]	Arco Electronic Inc.	Great Neck, N.Y.
[illegible]	HI-Q Division of Aerovox	Myrtle Beach, S.C.
[illegible]	Precision Paper Tube Co.	[illegible]
[illegible]	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif
[illegible]	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
[illegible]	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
[illegible]	Fairchild Co. Inc. Western Div.	Culver City, Calif.
[illegible]	Automatic Electric Co.	Northlake, Ill.
[illegible]	Sequoia Wire Co.	Redwood City, Calif.
[illegible]	Precision Coil Spring Co.	El Monte, Calif.
[illegible]	P.M. Motor Company	Westchester, Ill.
[illegible]	Component Mfg. Service Co.	W. Bridgewater, Mass.
[illegible]	Twentieth Century Plastics Inc.	Los Angeles, Calif.
[illegible]	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
[illegible]	[illegible] Inc.	San Mateo, Calif.

Code No.	Manufacturer	Address
01539*	Union Carbide Corp. Linde Div., Kemet Dept.	Cleveland, Ohio
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05646	Cosmo Plastic	
[illegible]	[illegible] Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05828	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05829	Metro-Tel Corp.	Westbury, N.Y.
05863	Stewart Engineering Co.	Santa Cruz, Calif.
05880	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co. Div. of Stewart Warner Corp.	Bridgeport, Conn.
06040	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06407	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Semcor Div. Components Inc.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Fairmont Corp.	New York, N.Y.
07233	Cinch Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Britchet Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08356	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc. Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations Div. of C.B.S. Inc.	Lowell, Mass.
09004	Mec-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atomic Elect.	Burbank, Calif.
09276	Electro Assemblies, Inc.	Chicago, Ill.
09565	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.

Code No.	Manufacturer	Address
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc. Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Metabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermalloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15556	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Instr. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Ametek Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Meta Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co. Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Curtis Instrument Inc.	Mt. Kisco, N.Y.
18640	E.I. DuPont and Co., Inc.	Wilmington, Del.
18691	Durant Mfg. Co.	Milwaukee, Wis.
19050	The Bendix Corp. Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. of McGraw Edison Co.	West Orange, N.J.
19666	[illegible]	Baldwin Park, Calif.
19804	L&C Electronics	Homemeads, N.Y.
19871	Electra Mfg. Co.	Independence, Kansas

CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G E Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg Co.	Kenilworth, N.J.
33173	G E Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co	Chicago, Ill.
43990	C A Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg Co.	Skokie, Ill.
46384	Penn Eng & Mfg Corp.	Doylestown, Pa.
47904	Polaroid Corp	Cambridge, Mass.
48620	Precision Thermometer & Inst Co.	Southampton, Pa.
49956	Microwave & Power Tube Div	Waltham, Mass.
52090	Rowan Controller Co	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg Co	Selma, N.C.
55026	Simpson Electric Co	Chicago, Ill.
55933	Sonotone Corp	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp	Tulsa, Okla.
59730	Thomas & Betts Co	Elizabeth, N.J.
60741	Triplett Electrical Inst Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co	Owosso, Mich.
63743	Ward Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst Inc Weston Newark	Newark, N.J.
66295	Wirlen Mfg Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg Co Revere Mincom Div.	St Paul Minn.
70276	Allen Mfg Co	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc	Chicago, Ill.
70563	Amperite Co., Inc	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg Co	Chicago, Ill.
70998	Bird Electronic Corp	Cleveland, Ohio
71007	Birnbach Radio Co	New York, N.Y.
71041	Boston Gear Works Div of Murray Co. of Texas	Quincy Mass.
71054	Bud Radio Inc	Willoughby, Ohio
71286	Camloc Fastener Corp	Paramus, N.J.
71313	Cardwell Condenser Corp	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg Div of McGraw-Edison Co.	St Louis, Mo
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg Corp	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg Co.	Erie, Pa.
76210	C W Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg Co., Inc.	Malden, Mass.
76493	J.W Miller Co.	Los Angeles, Calif.
76530	Cinch Monadnock, Div of United Carr Fastener Corp.	San Leandro, Calif.
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77252	Philadelphia Steel and Wire Corp	Philadelphia, Pa
77342	American Machine & Foundry Co. Potter & Brumfield Div	Princeton, Ind
77630	TRW Electronic Components Div.	Camden, N.J
77638	General Instrument Corp., Rectifier Div	Brooklyn, N.Y
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp of Calif.	Torrance, Calif
78189	Shakeproof Division of Illinois Tool Works	[illegible] Ill
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg Co	San Francisco, Calif
78488	Stackpole Carbon Co.	St Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co	Newtonville, Mass
79136	Waldes Kohinoor Inc	Long Island City, N.Y.
79142	Veeder Root, Inc	Hartford, Conn
79251	Wenco Mfg Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co	Morristown, N.J
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards Washington, DC	
80207	Unimax Switch, Div Maxon Electronics Corp	Wallingford, Conn
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div of Robertshaw Controls Co.	Columbus Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec Div Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Calif
81541	Airpax Electronics, Inc.	Cambridge Maryland
81860	Barry Controls, Div Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.

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83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp	Mundelein, Ill.
83330	Smith, Herman H., Inc	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84042	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp of America, Electronic Comp. & Devices Div.	Harrison, N.J.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif
89472	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90920	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect. Inc.,	Salem Div. Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
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91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
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91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
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94137	General Cable Corp.	Bayonne, N.J.
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94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
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95987	Weckesser Co.	Chicago Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
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97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
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98159	Rubber Teck, Inc.	Gardena, Calif.
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98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
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98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Allee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

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0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

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Olander Associates Latin America
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TURKEY
Telekom Engineering Bureau
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UNITED KINGDOM
Hewlett-Packard Ltd.
224 Bath Road
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Tel: Slough 28406-9, 29486-9

YUGOSLAVIA
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Madras 2
Tel: 86339

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B-7, Ajmeri Gate Extn.
New Delhi 1
Tel: 27-1053

IRAN
Telecom, Ltd.
P. O. Box 1812
Teheran
Tel: 43850, 48111

ISRAEL
Electronics & Engineering
Division of Motorola Israel Ltd.
16, Kremenetski Street
Tel-Aviv
Tel: 35021/2/3

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Shinhankyu Building
No. 8, Umeda
Kita-ku, **Osaka** City
Tel: 313-0091

Yokogawa-Hewlett-Packard Ltd.
Ito Building
No. 59, Kotori-cho
Nakamura-ku, **Nagoya** City
Tel: 551-0215

Yokgawa-Hewlett-Packard Ltd.
Ohashi Building
No. 59, I-chome, Yoyogi
Shibuya-ku, **Tokyo**
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KENYA
R. J. Tilbury Ltd.
P. O. Box 2754
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Seoul P. O. Box 1103
112-35 Sokong-Dong
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Tel: 3.7049, 3.7613

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Constantin E. Macridis
Clemenceau Street
Clemenceau Center
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Tel: 220846

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8 Matipo Street
Onehunga S.E. 5
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Zirat Chambers
31, Jinnah Avenue
Dacca
Tel: 80058

PAKISTAN (WEST)
Mushko & Company, Ltd.
Oosman Chambers
Victoria Road
Karachi 3
Tel: 51027, 52927

SOUTH AFRICA
F. H. Flanter & Co. (Pty.), Ltd.
Rosella House
Buitencingle Street
Cape Town
Tel: 3-3817

F. H. Flanter & Co. (Pty.), Ltd.
104 Pharmacy House
80 Jorissen Street
Braamfontein, **Johannesburg**
Tel: 724-4172

TAIWAN
Hwa Sheng Electronic Co., Ltd.
P. O. Box 1558
21 Nanking West Road
Taipei
Tel: 46076, 45936

THAILAND
The International
Engineering Co., Ltd.
P. O. Box 39
614 Sukhumvit Road
Bangkok
Tel: 913460-1-2

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard Export Marketing
1501 Page Mill Road
Palo Alto, California 94304
Tel: (415) 326-7000
Telex: 034-8461
Cable: HEWPACK Palo Alto

MANUAL BACKDATING CHANGES

MODEL 313A

TRACKING OSCILLATOR

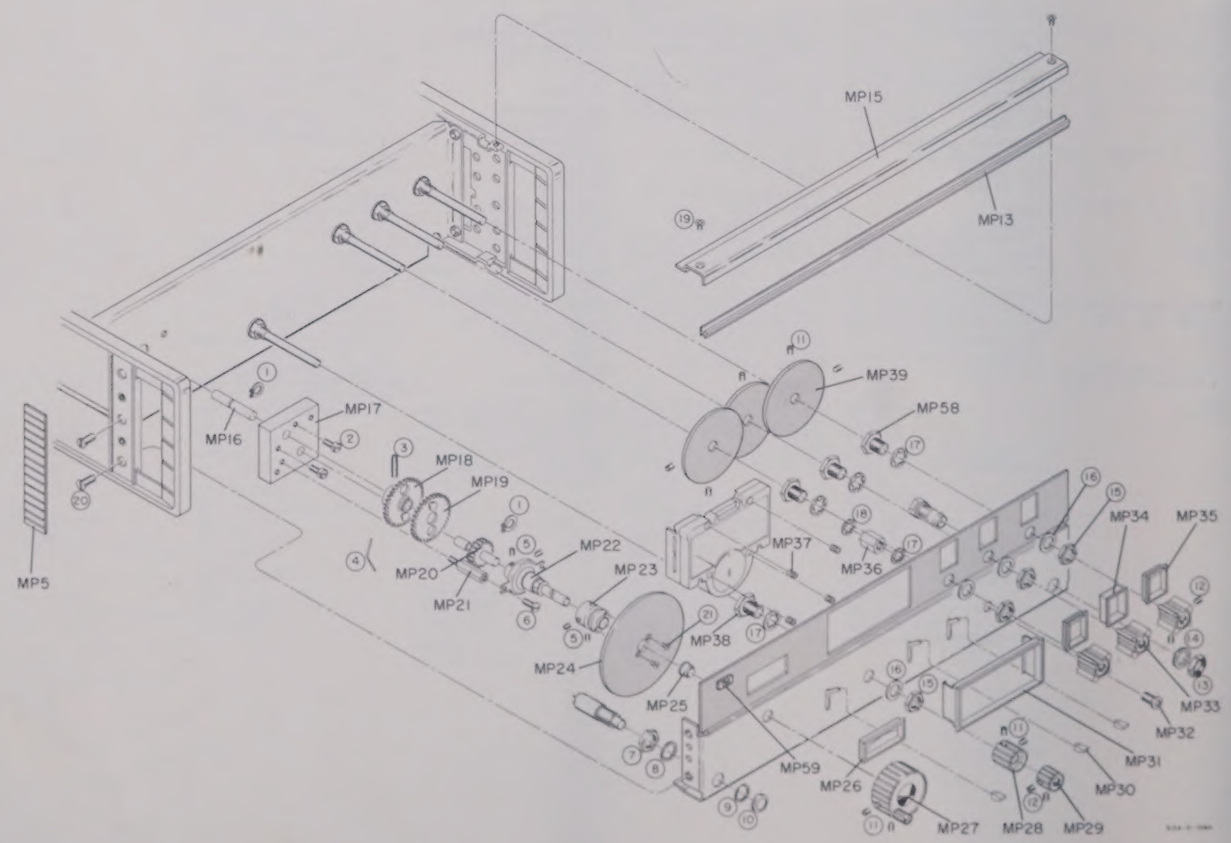
-hp- Part No. 00313-90001
Serials Prefixed: 709-

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
709-00151 and below	1		

CHANGE #1 Change the part numbers of the mechanical parts as shown below. All other parts are the same as those listed in Table 6-1.

MP-16	00313-23701	MP-23	5020-0237
MP-20	00313-23601	MP-30	5040-0452
MP-22	1500-0751	MP-41	5020-0354



00313-90001

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